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Development of a Model Sanitary Landfill Site Design for Snohomish County, Washington

Snohomish County Dept of Public Works, Everett, Wash

Prepared for

Environmental Protection Agency, Seattle, Wash Solid Waste Management Program

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DEVELOPMENT OF A MODEL SANITARY LANDFILL SITE DESIGN FOR SNOHOMISH COUNTY, WASHINGTON

by

Snohomish County Department of Public Works
Solid Waste Division
County Administration Building
Everett, Washington 98201

Prepared for

U.S. Environmental Protection Agency
Region X
Air and Hazardous Materials Division
Solid Waste Management Program
1200 Sixth Avenue
Seattle, Washington 98101

Grant Number: S-801761

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The report briefly describes the process of site selection and design for a major, regional sanitary landfill in Snohomish County, Washington. Unique features in the design included the need to provide a substantial level of ground water protection because of the high rainfall in the area. The site selection and design was also affected by the area's glaciated soils. Copies of the design report and preliminary site development plans are appended.

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PREFACE

In March of 1973, Snohomish County, Washington, was awarded $150,000 under Section 204 of the Solid Waste Management Act as amended. The purpose of the award was to provide partial support to the County in the development of a regional solid waste management system. The funds provided by the EPA marked the beginning of a comprehensive, six year solid waste management implementation program.

The primary objective of the grant program was to develop and make available for public examination an operating, model sanitary landfill, together with the associated design plans, reports, and environmental impact statement. As of this date, the County has not been successful in achieving an operating landfill. However, the design plans, reports, and an environmental impact statement have been completed. These documents, in themselves, should serve as a valuable resource to other persons confronted with the need to develop final disposal sites for solid waste.

To provide for the dissemination and public review of this information, a series of three reports has been prepared. These reports are as follows:

1. "Development of a Regional Solid Waste Management System For Snohomish County, Washington."

2. "Development of a Model Sanitary Landfill Site Design For Snohomish County, Washington."

3. "Development of a Sanitary Landfill Environmental Impact Statement For Snohomish County, Washington."

Each report relates to a specific area of interest and stands alone in that regard. At the same time, each report discusses only one aspect of a broad planning and implementation effort. Readers interested in a more thorough analysis of any of the specific reports, or a more general analysis of the Snohomish County Solid Waste Management Implementation Program, should review all three of the reports.

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SUMMARY

The purpose of this report is to aid agencies and municipalities in selecting and designing a modern sanitary landfill site. This report will be most useful to those persons desiring to select and design a landfill in areas of historically high rainfall and high groundwater tables.

This report will also describe to the reader a method by which a sanitary landfill site can be selected and designed concurrent with the preparation of the environmental impact statement. By utilizing this process, as environmental impacts are identified, the design can be modified to mitigate those impacts. The report describes those criteria which should be utilized for selecting a sanitary landfill site. These criteria tend to emphaisze minimization of these environmental impacts.

The design of this sanitary landfill has several unique features which might be of interest to the reader. These include a background water quality monitoring program conducted far in advance of construction of the sanitary landfill; extensive precautions for the prevention of groundwater contamination, leachate collection, and treatment. The design of the sanitary landfill is phased or staged to minimize environmental impacts and to afford flexibility

in terminating the operation if so desired.

It can be concluded from this report that a modern sanitary landfill can be selected and designed to operate in areas of high groundwater tables and high net annual rainfall without contaminating surface or ground water and minimizing ancillary impacts.

I. INTRODUCTION

This report will describe how Snohomish County, Washington, selected a sanitary landfill site and arrived at an ultimate design. Appended to this report is Volume I and Volume II of the sanitary landfill Design Report. Volume I (Appendix A) is the site design showing location and construction of most of the major features of the landfill. Volume II (Appendix B) contains supportive data for Volume I, such as water quality monitoring data, soils investigations, geological research, and percolation testing of the bedrock. Close scrutiny of the appendices will provide the reader with an opportunity to examine those features necessary for the operation of a sanitary landfill in an area of high rainfall. These documents depict a landfill built to very high standards of environmental protection.

Anyone contemplating construction of a sanitary landfill in an area where protection of groundwater quality is paramount will find the appended designs useful. Because the expertise required to design a sanitary landfill to these high standards was not possessed by Snohomish County, an engineering consultant was retained to aid in the site selection and develop the site design. The consultant's obligation was to produce: 1) Evaluations of the sites selected by Snohomish County as candidates for the sanitary landfill; 2) Once final selection had been made, the consultant was to produce an acceptable design; 3) And the consultant, together with the County, was to write a draft and final environmental impact statement. Additionally, the consultant was to have recognized experts in the field of solid waste management available for permit hearings, if needed. The contract negotiated with the general consultant was a "cost plus" to a maximum ceiling type. It was felt by the County that more quality work could be obtained with this arrangement than by a "fixed price" contract.

II. BACKGROUND INFORMATION

Snohomish County, located in the western half of the State of Washington, is approximately 1900 square miles and has a population of about 260,000 people. On the eastern side of the County are located the rugged Cascade Mountains, which make approximately one third of the land area unusable for urbanization. On the western perimeter of the County is located Puget Sound, a major port for shipping lines to the Orient. Because Snohomish County is relatively close to the Pacific Ocean and is backed on the east by high mountains, moist, humid air coming from the west off the ocean tends to deposit the majority of the precipitation in Snohomish County rather than carrying it on further to eastern areas of the state. As a result, Snohomish County is typified by areas of high rainfall to areas of extremely high rainfall and has warm, moderate temperatures throughout both the summer and winter.

Geologically, Snohomish County is underlain by soil strata of a relatively impermeable nature. Because the County has high rainfall and relatively impermeable soils, high groundwater tables throughout the area typify Snohomish County's groundwater situation. Obviously, when determining the selection of the proposed sanitary landfill site and designing that site, high groundwater tables played a very serious role in this process.

Fortunately, the County is served by a major transportation route in the form of an interstate highway running north and south from border to border in the western portion of the County. One major mountain pass is served by an all-weather, heavy-duty highway originating from the interstate highway and heading to the east. The County has developed a "corridor" type demographic distribution running parallel to and adjacent to the major interstate highway with the most dense populations found in the southwest portions of the County between the interstate highway and the bay.

III. INITIAL SITE SELECTION

In 1971, Snohomish County initiated development of a solid waste management planning effort, funded in part by the Department of Housing and Urban Development and conducted by the Snohomish County Planning Department. This planning effort, WASH-USE-1, addressed the problem of solid waste disposal in the County. It determined that the existing disposal system consisting of fourteen open dumps and/or improperly operated landfills was not capable of serving the County in an environmentally suitable manner. In addition, the landfill which served the City of Everett, the major metropolis in the County, was determined to be nearing capacity with no replacement available. The conclusion was then arrived at that new solid waste disposal facilities would have to be developed in the immediate future if the County was to prevent a crisis because of the unavailability of a means of waste disposal.

The planning effort concentrated on selecting an appropriate means for solid waste disposal that would serve the County in the most cost/effective and environmentally suitable manner. A number of potential alternatives were evaluated, including incineration and various resource recovery techniques. The conclusion reached in the evaluation was that sanitary landfills were the most cost/effective alternative for waste disposal at that time for the conditions existing in Snohomish County.

The planning effort, then, attempted to identify potential sanitary landfill locations. Many individuals, recognizing the County's need for a solid waste disposal site, came forward and offered potential sites of their own. These people included land speculators, County employees who knew of potential sites, and, in some cases, independent disposal site operators. The County decided to utilize the services of real estate brokers to identify parcels of land which were or might be available for purchase. This was necessary since the County did not have condemnation authority for obtaining land for a sanitary landfill. Criteria were developed for identifying available parcels as potential sanitary landfill sites. The criteria included requirements that the site must be readily accessible by a major County roadway and that the site, if developed as a sanitary landfill, would not conflict with existing and forecasted land use in the vicinity. In addition, identified sites were assessed as to topography and soils characteristics using available maps provided by the United States Coast And Geodetic Survey and the Soil Conservation Service. Using this process, seventeen sites were identified as potential locations for sanitary landfills.

The WASH-USE-1 planning program analyzed the seventeen potential landfill sites by comparing operations, implementation, and transport costs through use of a computer program. The results of this analysis, then, enabled the sites to be ranked according to least cost. While expense is a very important parameter to consider in the site selection process, it should not be the sole criterion. It's important to consider other parameters during the site selection process such as the aesthetic impact on surrounding property owners, ability to control pollutants produced by the landfill site, visual and noise obscuring buffers, and other items principally relating to environmental impact. However, in this particular case, these other items were not considered during initial selection. The County was looking for a least cost solution solution primarily, and the site which was recommended as being least costly was located near Paine Field, an airport used by private aircraft and by the Boeing Company in conjunction with the 747 production facility.

The implementation effort appeared to be straightforward as the Paine Field location was initially judged to be acceptable for a sanitary landfill. Considerable opposition developed almost immediately, however, when it became known that the Paine Field site was being considered for a sanitary landfill. The Boeing Company requested a meeting with County staff and consultants. At the meeting, Boeing attorneys and technical staff questioned the location because of potential danger to aircraft using Paine Field. They felt that a sanitary landfill in the vicinity would attract birds, specifically seagulls, and that these birds would endanger aircraft because of the potential for collisions. In response to these concerns, an evaluation was made of the ability to control birds at the landfill site. The evaluation determined that while it was possible to keep birds away from a sanitary landfill operation, it was not possible to guarantee that birds would never be attracted to the site. This meant that there was the possibility that the County could be held liable if there was an aircraft accident. Because of this, the Paine Field location was dropped from further consideration as a sanitary landfill.

VI. FINAL SITE SELECTION

Up to this point, the initial site selection process had been conducted principally by the Snohomish County Planning Department. During the period of time when the Paine Field site was under consideration, a Department of Public Works, with responsibility for solid waste management in Snohomish County, was created. One of the tasks of the Department of Public Works was to complete the site selection process. The Department of Public Works, being the agency which was going to have to implement the landfill when it was finally selected, had certain criteria in mind which they would like to have in any sanitary landfill site located in Snohomish County. Primarily, these criteria were design oriented. The Department of Public Works wanted to find a landfill site which contained these certain criteria so that they would not have to be developed as part of the design later. Additionally, solid waste management legislation, which was either adopted or on the horizon, was starting to impinge upon the site design characteristics and, therefore, on the site selection criteria. By identifying these regulatory constraints and desirable operating characteristics, additional site selection criteria were developed to re-evaluate the sites previously selected in the planning study in order to select a preferred one for conducting engineering feasibility studies. These desired characteristics included the following:

On-site soils must be available for cover during landfill operations and with characteristics which would enable ample compaction for vector control and not hinder operations during wet weather.

An impervious sub-strata should be present to afford protection of groundwater contamination by leachate.

A defined on-site drainage pattern should exist, preferably draining to the site's center to enable diversion of surface waters and collection of leachate generated from the landfill.

Site topography and size should be sufficient to enable maintenance of a buffer area to shield landfill operations from adjacent areas and from public view during the site's operational life.

Site topography and soils conditions should allow development of the sanitary landfill in short time increments to afford flexibility and minimization of environmental impacts.

The site must be located above major flood plains and outside the vicinity of densely populated areas during its operational life.

To re-evaluate potential landfill sites, assistance was obtained from the United States Soils Conservation Service. This assistance included on-site reconnaissance surveys in which soils and topography were examined. In addition, sub-surface soils characteristics were determined in a preliminary nature by digging test pits with shovels and posthole diggers.

The re-evaluation of available sites culminated with the selection of two preferred candidate locations which could be developed as sanitary landfills to serve the urban portion of Snohomish County. A special consultant with expertise in soils and geology was then retained to assist in selecting between the two. After preliminary field examinations by the special consultant, it was determined that neither site was ideal for development as a sanitary landfill. In particular, both sites contained fine soils which could present operational problems during wet weather. Field examinations also indicated that groundwater surfaced occasionally on both sites in the form of springs and seeps, making drainage control and leachate attenuation difficult. It was decided that a more thorough site evaluation was required for both sites in order to selected either for design.

The evaluation of the two candidate landfill sites emphasized soils and geologic analyses. Backhoe test pits were utilized to examine sub-surface conditions, including defining soils types and strata locations and groundwater flow patterns. On the basis of these evaluations, one site was found to be completely unacceptable for a sanitary landfill. This conclusion was reached when sub-surface examinations found that the site was underlain by alternating strata of clay and sandy soils intersected by the site's surface. Groundwater then flowed through the sandy soil strata atop the clay materials and could surface on the site at a variety of locations as seeps and springs. It was determined that it would be extremely difficult, if not impossible, to prevent this water from discharging into a sanitary landfill area and thus increase the generation of leachate and polluted water. The second site under evaluation, referred to as the Wintermutes Corner site, was found to also contain sandy soils atop more impervious strata. The location of the soil strata and associated surfacing of groundwater could permit containment of surface and groundwaters, however, preventing contamination by solid waste placed at the site. It was determined that containment of surface and groundwaters would add considerable cost to development of the Wintermutes Corner site, however. In addition, the cost of purchasing the site was found to have increased substantially above that initially estimated. The initial cost estimate was based on a verbal understanding; and when actual negotiations began for purchase or lease of the site, the cost was considerably higher. Thus, serious reservations developed as to the suitability of the Wintermutes Corner site for a sanitary landfill.

Because of high costs associated with development of the Wintermutes Corner site, another alternative location was selected for detailed evaluation. This site, referred to as the Cathcart site, had been identified previously in the planning effort. The Cathcart site had not been seriously considered, however, because waste transport distances were greater for it than for the other sites considered, thus making it appear to be uneconomical because of haul costs. It was determined that a cost comparison should be developed for the Cathcart and Wintermutes Corner sites to make a final site selection. This comparison was needed to determine cost tradeoffs associated with the greater haul distances to the Cathcart site but possible higher development and operations costs of the Wintermutes Corner site. To complete this cost comparison, the Cathcart site was first evaluated in the same manner that the Wintermutes Corner site had been, including a detailed analysis of site drainage and sub-surface characteristics. A preliminary engineering design was completed for each site which emphasized design features which would differ between the two sites. This preliminary design included development of site layouts, soil excavation requirements, and preliminary selection and sizing of drainage and leachate control facilities. In addition, a preliminary environmental impact assessment was prepared for each site to assist in final evaluation.

The preliminary engineering studies first addressed site descriptions and locational considerations. Included in the locational considerations was a determination of the applicability of zoning and land use of the site and its vicinity. The availability of required access roads and utilities was also determined. A preliminary soils and geologic investigation was conducted for each of the sites using the services of a qualified soils engineer and geologist. These investigations included visual site surveys and preliminary sub-surface analyses utilizing test pits excavated by a backhoe. The purposes of the soils and geologic investigations included a determination of the workability of soils located at the sites for use as cover during sanitary landfill operations. In addition, a preliminary determiniation of the natural hydrology of the sites was made using the geologic data. This enabled a prediction of potential problems associated with leachate contamination of surface and ground waters.

A preliminary site layout was completed for each site to serve as the basis for estimates of the costs associated with site development. The layout also enabled estimates of the landfill operation life for each of the sites. The preliminary layout established requirements for site facilities and equipment and presented preliminary locations of design features. Also of importance was the determination of the need for site buffer areas to serve as a screen and containment for certain environmental impacts associated with sanitary landfill operations. Finally, a preliminary cost estimate was made for developing and operating sanitary landfills at each site.

A summary of the information developed in the preliminary site designs was then presented for use in the final selection of a sanitary landfill site. This information was divided into four categories: locational considerations, environmental considerations, operational considerations, and economic considerations. Locational considerations included waste transport distances and land use compatibility. Environmental considerations included defining the potential for water pollution at each site, hydrology and drainage effects, gas and odor considerations, noise considerations, and the ability to control vectors. Operational considerations included describing differences in site workability, differences in flexibility in developing or terminating operations at each site, and landfill life estimates. Finally, economic considerations included differences in initial costs and operational costs.

Based on the results of the final evaluation, the Cathcart site was selected for design as a sanitary landfill to serve the urban portion of Snohomish County. The site was found to have the lowest total annual cost of all sites analyzed and had the lowest potential for adverse environmental impact. The process undertaken to arrive at the final site selection involved considerable time and effort. The selection has resulted in considerable opposition from property owners in the vicinity of the Cathcart site, as can be expected in most instances when a new waste disposal location is sought. Without the time and effort that went into the site selection process, it would be impossible to convince the citizens of the County that the selected location was in fact the best alternative available.

V. DEVELOPMENT OF FINAL DESIGN

The final design process for the Cathcart Sanitary Landfill site included building on the efforts from the preliminary design process and refining design features in conjunction with the development of the environmental impact statement. As impact analyses were conducted, design features were developed or refined to reduce or eliminate identified adverse impacts.

The initial step in carrying out the final site design was the development of more complete and accurate soils and geologic information. This was done through the analysis of soil borings taken at the Cathcart site. Of special importance in these analyses was the definition of locations of various soils strata and a definition of their properties. This information then enabled an analysis of the leachate attenuating properties of the materials at the site, their workability, and the establishment of elevations for excavating soils for construction of the sanitary landfill.

It was determined early in the design process that the least amount of area possible would be developed and operated as a landfill at any one time. This would be done to minimize environmental impacts and to afford flexibility in terminating the operation if so desired. The landfill would then be developed in stages whereby operations could be conducted in one area as another area was being prepared. It was then necessary to define the locations and sizes of each staged operational area. In order to do this, the desired dimensions of landfill cells were established. These dimensions were based on the length required to provide needed access by waste transport vehicles and on a calculation of the dimensions which would require the least amount of cover material. Boundaries of the overall sanitary landfill area within the site were established based on buffer area, site access, and facility requirements. The dimensions of the staged operational areas were then established within the overall sanitary landfill area to complement the established cell dimensions and to allow for required access to the landfill operation by waste haul vehicles. The lower elevation of the landfill area was established based on soils and geologic information and on drainage requirements for collecting leachate which would form at the bottom of the landfill.

On-site facility requirements were then established and designed. These include access roads, buildings, a truck washing facility and utilities. Of primary emphasis was the design of drainage and water pollution control facilities as this effort was deemed critical for minimization of environmental impact. It was determined that two separate systems should be developed for drainage control--one for drainage entering the site at its perimeter (off-site surface run-off), and one for drainage within the site perimeter (on-site surface run-off drainage). The purpose of the off-site surface water collection system is to divert drainage around the site, thereby minimizing the amount of water which could potentially be contaminated through contact with waste deposited at the site. This was done through the design of an intercepting and diversion ditch which would transport drainage around the site in a manner which would have a low erosion and sedimentation potential. The on-site drainage system design consists of a pipe network eventually to be located under the fill areas to transport surface run-off waters off-site. The pipe network would be protected with an impervious material to prevent leachate contamination and would only function during the life of the sanitary landfill operations. After completion of the landfill, the off-site drainage collection system would serve as the collector for all drainage.

The development of methods for preventing leachate contamination of ground and surface waters was approached in a conservative manner. The Cathcart site is located in an area of high net annual rainfall where a history exists of water quality problems associated with solid waste disposal sites. It was thus determined that all practicable means would be developed to prevent water quality degradation. The concept of diverting all drainage around the landfill area is the first step in this process, aimed at allowing the least amount of water possible to enter the fill area and thus become contaminated. The second design concept involves establishment of a barrier for preventing any leachate generated at the site from migrating through the bottom soils into the groundwater. Soils investigations indicated that materials on the site were relatively impervious and would afford a certain degree of leachate attenuation. It was determined, however, that an additional barrier would be necessary. Testing of available materials for use as a barrier is recommended prior to selection of the specific sealant material.

The final concept in the prevention of water quality degradation is the development of a leachate collection and treatment system. It is anticipated that the attenuation provisions will result in the lack of leachate movement out of the area. A monitoring program was developed (and is described in Appendix A) to determine if leachate generation could present a potential water quality problem, however. In the event that leachate generation is detected, a system was designed to collect and treat the pollutant. This system consists of a collection pipe located at the lowest elevation of the fill area. Leachate would flow along the impervious lower level of the fill area, be collected in the pipe and transported to a treatment facility. The treatment facility would consist of an aerated lagoon and physical chemical treatment system. A monitoring program is also recommended to establish that the treatment system is adequate since little information exists to enable prediction of treatment efficiencies when leachate is being handled. If the treatment system is found to be inadequate, storage and off-site transport of polluted waters is recommended.

The final step in the design was the determination of the site development process. This process consists of site preparation, the sanitary landfill operation, and the development of the final site use. Each sequence is described in order to enable the site to be developed in the appropriate manner, resulting in a final topography desired for potential land uses.

Certain features in the design of this landfill are unique and are considered to be significant. The first of these is the background water quality monitoring program which was begun so that at least 24 consecutive months of data could be accumulated prior to the landfill becoming operational. This was achieved by boring six wells down to the first impervious sub-strata. The wells are distributed throughout the site. These sampling wells are two inches in diameter, made out of polyvinyl chloride pipe, and have the well points designed such that water can pass into the wells but surrounding silt and sediment cannot. The wells were then sampled by a simple vacuum hand-pump every two weeks for the first 18 months and once a month thereafter. The samples collected were subjected to an extremely wide range of analyses so as to cover all possible or probable contaminants which might be expected from the landfill once it's operational. The data derived from the background water quality monitoring program appears in Appendix B of the attached appendices. Once the landfill becomes operational, the water quality monitoring program will be continued via peripherally located groundwater monitoring wells. The data derived during the ongoing water quality monitoring program will be continually compared to the background quality data which was obtained prior to the opening of the landfill. During operation of the landfill, groundwater samples will be subjected to a variety of analyses with different sampling schedules for different parameters. The proposed ongoing water quality monitoring program is described in detail in Volume I of the appended Design Report (Appendix A).

Another unique attribute of the design of the Cathcart Sanitary Landfill is the drainage and pollution control facilities. Basically, the drainage and pollution control facilities are designed to do three things: 1) Reduce the net infiltration of water into the solid waste; 2) Collect the net ex-filtration of water coming out of the solid waste and treat it; and, 3) Provide the basic facilities that could later be modified for use in a park-like setting. Reduction of the net infiltration of water into the solid waste was accomplished by diverting the off-site surface run-off water via channelization of an on-site stream and by application of an impermeable final cover to the solid waste. To enable the County to collect the ex-filtrated water as it percolates from the solid waste, a complex system of perforated pipe underdrains, in situ impermeable soil strata, and artifically applied impermeable seals under the solid waste are used. To provide a park-like setting compatible with the final use of the landfill and to divert surface water away from the landfill, the channelized on-site stream was dammed at one point to provide a large reservoir facility. The stream running from the reservoir was diverted to keep it away from the active solid waste working area, and flows over several manmade waterfalls. On-site surface water will be collected behind a dam at the downgrade end of the property to form a second permanent reservoir on the site. This reservoir will act as a settling pond for sediment removal during the active life of the landfill and as a potential recreation area during the final use stage.

The final feature about this landfill that's considered unique is the gas control system. Gases produced by the decomposing solid waste will be allowed to move laterally through the landfill by the construction of gravel-filled ditches at the highest point of each daily cell. The gas from the entire fill will be collected through a gravel wall on the north, east, and west side of the fill. The top of the gravel wall will be sealed with impervious soils to keep water from running down the gravel wall into the solid waste.

Penetrating down through the impervious soils and into the top of the gravel wall will be aluminum vent pipes which will allow the accumulated gases to disperse into the atmosphere. If it is found at a later date that these gases are producing a nuisance because of their odors or a hazard because of their flamability, they can then be collected via a header and burned safely similar to the manner in which methane gas produced at a sewage treatment plant is burned.

VI. CONTENT OF THE APPENDICES

Volume I of the Design Report explains the design and operation of the landfill in depth. It begins by describing the design criteria initially set down which led to the ultimate design of the Cathcart Sanitary Landfill. Certain assumptions are made regarding the average daily traffic volume and the average daily waste load. Decisions were arrived at which determined the controlling cell dimensions. Based on this initial data, typical solid waste cells could be designed for the sanitary landfill.

Certain items necessary for the operation of the sanitary landfill are identified in Volume I and includes such buildings and facilities as the gatehouse and scale, truck washing facility, the necessary utilities such as power, water, telephone, radio, and sewage disposal facilities.

Volume I provides the information necessary to conduct a very comprehensive groundwater quality monitoring program. Specific parameters for analysis are discussed as well as sampling frequency. The site development sequence section of Volume I of the Design Report describes in general terms the step by step process through which the sanitary landfill site is prepared, operated, and put to its final use. It is very important in that it contains soil volume estimates. Without these soil volume estimates, it would be impossible to adequately predict the volume of various soils necessary to operate the landfill through to its conclusion.

Finally, Volume I contains the actual design drawings of the landfill, stage by stage, plus all of the ancillary facilities which will be constructed to operate the landfill.

Volume II of the Design Report attached in the appendices contains most of the supportive documentation necessary to design the landfill. Primarily, this information is oriented around the soil and geological characteristics of the site. Cross sections are shown, as well as depth to groundwater, impervious sub-strata, and percolation rates. The water quality data accumulated over the first 18 months of the water quality monitoring program will be found in Volume II of the Design Report. The sample point designations in the water quality reports correspond to the boring location shown in Volume I, Page 2.

The "heart" of this report is in the attached appendices Volume I and Volume II. If the reader desires to learn the details of sanitary landfill construction in wet weather situations, it is recommended that the Design Report be carefully perused.

Appendix "A"

Cathcart Sanitary Landfill

Design Report
Volume I

Snohomish County
Public Works Department

Stevens, Thompson & Runyan, Inc.

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SOLID WASTE DISPOSAL SYSTEM

SNOHOMISH COUNTY

CATHCART LANDFILL

DESIGN REPORT

VOLUME I

AUGUST, 1975

Stevens, Thompson & Runyan, Inc.
Engineers / Planners
PORTLAND · SEATTLE · BOISE · SPOKANE

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PURPOSE AND SCOPE

The purpose of this report is to summarize the design effort to date, present the criteria used in the design and identify the steps to be taken to implement operation of the facilities.

EXISTING CONDITIONS

The 200-acre Cathcart site is located along State Highway No. 9 approximately 3-1/2 miles south of the City of Snohomish. The existing conditions at the site are described in the report entitled, "Solid Waste Disposal System, Snohomish County Facility and Operational Plan Design, Phase I - Report No. 2," a copy of which is included in this report as Appendix A.

Since the previous report was prepared, additional information regarding existing conditions has been obtained. This information includes more detailed soils information and existing ground and surface water quality.

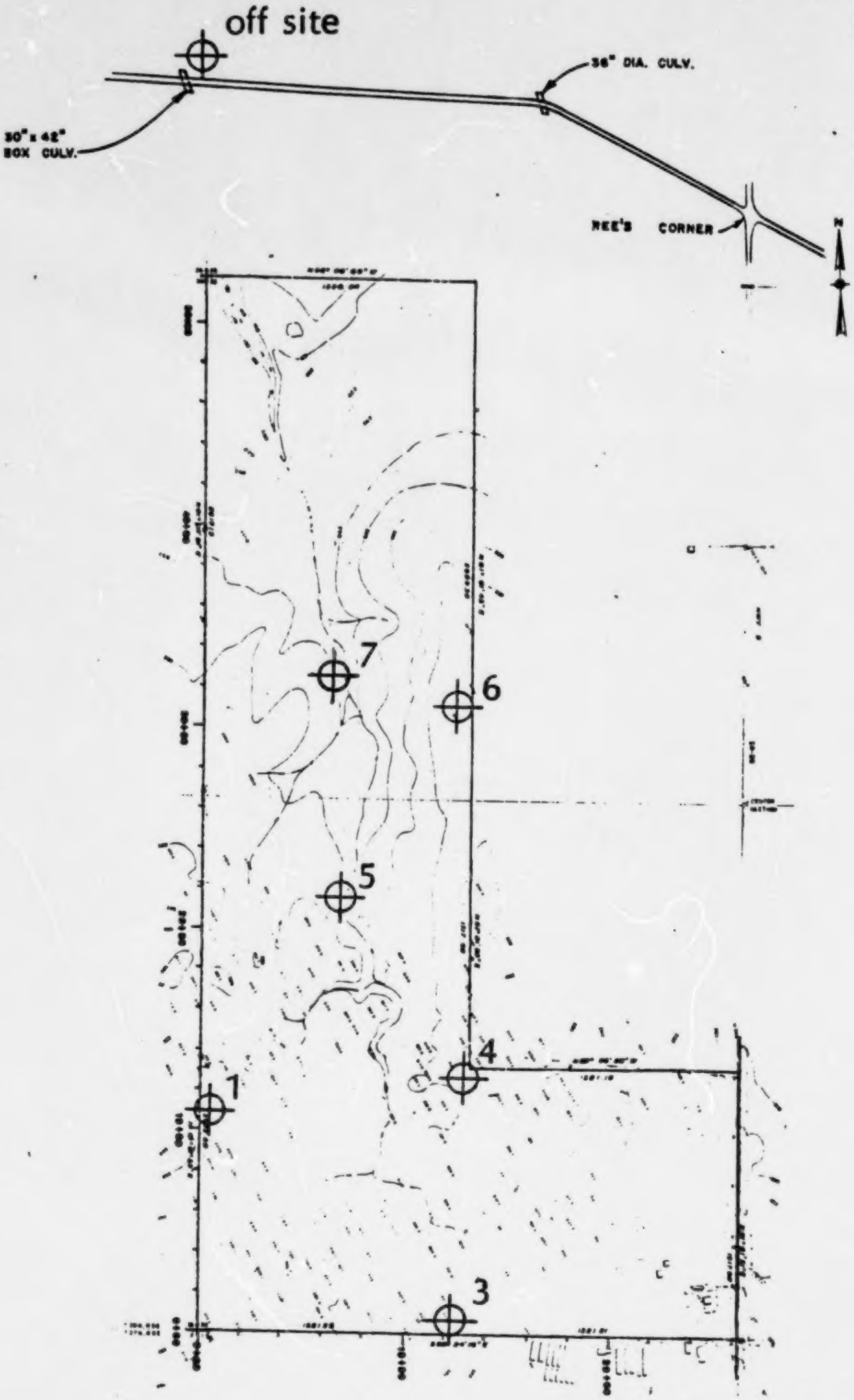
The soils information is presented in three reports (W-1035-62 dated October 15, 1973; W-1035-64 dated February, 1974; and W-1035-66 dated August 9, 1974) by Geolabs - Washington, Inc. Copies of the reports are attached as Appendices D, E, and F.

The State of Washington Department of Ecology has analyzed samples of ground and surface water surrounding the Cathcart site since the end of March, 1974. The samples have been taken bi-monthly at the locations shown on Figure 1. The test results are shown in Appendix B. These data show that the groundwater has higher concentrations of total organic carbon, chemical oxygen demand, turbidity, and dissolved solids than the surface waters on the site. The quality of the surface waters appears to be relatively high. These data will provide background information to detect possible future changes in water quality caused by landfill operations.

FACILITY DESIGN CRITERIA

Preliminary design drawings and development plan are shown in Appendix C. These drawings show the location and preliminary design of the following functional elements:

Waste disposal area
Roads
Buildings and facilities
Utilities
Drainage and pollution control facilities
Water quality monitoring stations
Gas control systems
Landfill equipment
Buffer zone and reserve areas
Fencing


off site
30" x 42" BOX CULV.
36" DIA. CULV.
REE'S CORNER
N
7
6
5
4
1
3

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LOCATION OF WATER MONITORING STATIONS

Figure 1

Detailed descriptions of each element are presented in following sections.

Waste Disposal Area

Approximately 56 acres of the site will be developed as a waste disposal area as shown on Sheet 1 in Appendix C. The disposal area will be developed in six stages. Based on the estimated solid waste quantities listed in Table 1, the life of the landfill will be seven to ten years.

Table 1

Estimated Solid Waste Design Quantities

Year	Tons per Year
1975	147,000
1980	161,000
1985	178,000
1990	196,000

The area of each stage will vary from eight to twelve acres. The first stage of approximately 11 acres will be cleared, excavated, and prepared for receiving the solid wastes and the second stage of approximately 10 acres will be cleared and excavated as part of the initial site preparation. Part of the excavated soil will be stockpiled in the second stage area for use as daily cover during the first stage landfill operation. Before the first stage is filled with four lifts of solid waste, the second stage area must be prepared for receiving solid wastes and the third stage area must be cleared and excavated. The first stage area can be only partially filled with four lifts of solid waste because truck maneuvering space will become limited at higher elevations. The second stage area will then be filled to the same elevation as the first stage, and both areas can be filled to final elevation. Time to complete the first and second stage areas is estimated at approximately 3 years. Truck maneuvering space should not be restricted in other stages. The same basic sequence of conducting the sanitary landfill operation in the first stage while preparing the second stage and excavating the third stage will be followed for the remaining stages. As each stage is completed to final elevation, the area will receive the final cover material, final grading, gas controls, and be seeded with grass.

The landfill operations have been developed in accordance with the following design criteria:

1. Average Daily Waste Load = 535 tons per day on average weekday of average month in year 1975, based on a 6 day work week.

2. Average Daily Traffic Volume = 50 trucks per day or 10 trucks per peak hour on average weekday of average month in year 1975.

3. Basic Cell and Lift Construction Criteria

    a. Intermediate cover = 12-inch thickness each day
    b. Working face cover = 6-inch thickness each day
    c. Slope of working face = 3 horizontal to 1 vertical
    d. Slope at end of cell = 3 horizontal to 1 vertical
    e. Compacted waste density = 1,000 lb/cu. yd. (average)
    f. Cover loss factor = 1.5

4. Controlling Cell Dimensions

    a. Length of open working face should not exceed 75 feet. Incoming traffic will require 45 feet of unloading length for the average weekday load condition, 45 feet of unloading length for peak month average weekday load condition, and 75 feet of length on peak days.

    b. Maintain a constant height of compacted waste (cell height) at 9 feet and a constant thickness of compacted waste (cell thickness) of approximately 22.6 feet. Allow the working face length to vary with the daily waste load and corresponding traffic.

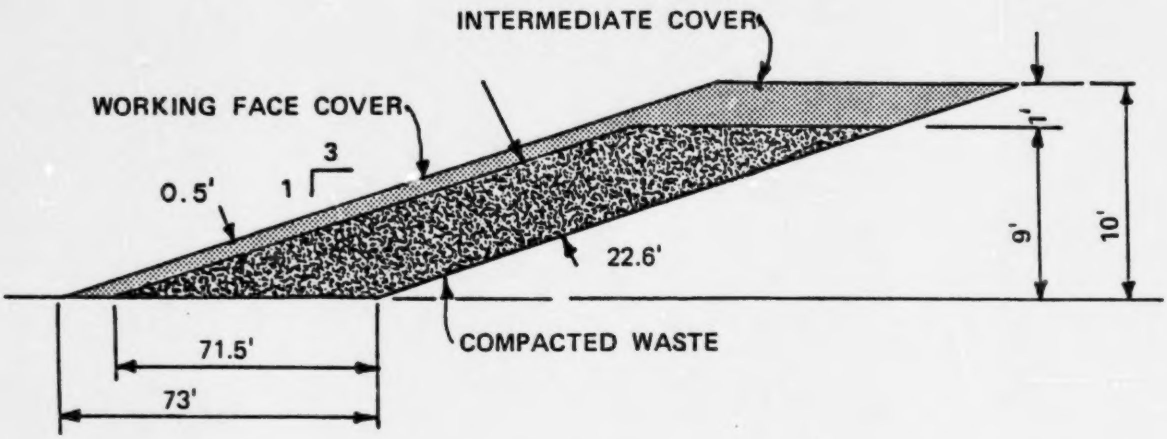
Figure 2 shows a typical cell section. Final contours of the completed landfill are presented in Appendix C.

Approximately 80 percent of weekday wastes will arrive by transfer truck with average payload of 16.5 tons per truck. The remaining 20 percent of weekday wastes will arrive by collection vehicles with average payloads of 3.75 tons per truck. Transfer trucks only are expected on weekend days.

Access Roads

The access to the site will be off of State Highway No. 9. The all-weather, permanent site access road will extend approximately 5,200 feet from the highway to the north end of the landfill area as shown in Appendix C. The design of the site access road should be for use by large trucks and tractor-trailer combinations.

Preliminary design indicates that the road should have a twenty-eight foot wide paved section with four foot wide shoulders.


INTERMEDIATE COVER
WORKING FACE COVER
3
1
0.5'
22.6'
1'
9'
10'
COMPACTED WASTE
71.5'
73'

NOTE: THE DAILY CELL CONSISTS OF THE COMPACTED SOLID WASTE PLUS THE DAILY COVER (WORKING FACE COVER PLUS INTERMEDIATE COVER) A SERIES OF ADJACENT CELLS MAKE UP A LIFT.

TYPICAL CELL SECTION

Figure 2

Maximum roadway grade should be six percent and the minimum centerline radius should be 100 feet.

Temporary unpaved access roads to the waste disposal area must be constructed as required. These temporary roads should be twenty-eight feet wide for two lanes, or eighteen feet wide for a single lane.

Buildings and Facilities

Approximate location of the miscellaneous buildings and facilities are shown on the location plan in Appendix C.

Gate House and Scale

The gate house and scale location near the top of the ridge will provide approximately 1,000 feet of on-site road for traffic backup, which sufficiently exceeds the minimum requirement of 400 feet. The location also allows existing trees and topography to act as screening to the highway and adjacent residences.

Buildings

The operation of a landfill at the site will require two buildings and related features such as parking areas. Approximately two acres have been designated for the buildings as indicated on Sheet 1 in Appendix C.

The employee and office facility will include a lunchroom, a washroom, lockers, an office area, and adjacent parking for visitors. The facility could be either a permanent building or a prefabricated, mobile unit. The location designated will provide a permanent site using land less suited for general waste disposal. An office building located near the top of the ridge will allow visual observation over nearly all of the site. The location is also reasonably close to the existing utilities and, in addition, this location would keep visitors away from the landfill operations.

A covered storage shed should be provided for routine maintenance of the landfill operating equipment. The proposed location of the vehicle storage shed is in a portion of the building area. This location would reduce the utility construction cost and keep the building in the same general area as other buildings. Another consideration would be to provide a portable shed that could be initially located near the landfill area and possibly moved as stages of the landfill are developed. It is anticipated that approximately one-half acre would be required.

Truck Washing Facility

It is desirable that a facility be provided for external cleaning of the collection vehicles and other trucks before they return to State Highway

No. 9. This would help assure the cleanliness of the public roadways near the landfill site.

The truck washing facility should be located back from the highway as far as possible to reduce the amount of water tracked on the public highway by wet trucks. The facility will require a permanent area of approximately 70 feet wide by 300 feet long alongside the exit lane of the permanent access road. A location just past the gate house is recommended for reasons of permanency, nearness to water supply, consolidation of facilities into one area and advantages of the gate house personnel being able to visually monitor operation. This location, however, may be poorly suited for disposal of large volumes of wastewater by drainfield. The facility design should, therefore, include means for reusing the wastewater to minimize quantities for disposal. Wastewater disposal methods will depend upon the type of truck wash facility selected. Methods of wastewater disposal could include a drainfield, storage facilities with trucking of the wastewater to the leachate treatment facility, or piping to the leachate treatment facility. Sludge and litter could be placed in the sanitary landfill.

Utilities

Utility requirements of the different locations on the site are summarized in Table 2. All public utilities, except sanitary sewers, are available and located along State Highway No. 9.

Power

The controlling power requirements will be those for the leachate treatment facilities (described later). The aerator in the leachate aerated lagoon will require a three-phase, 480-volt power supply. This is available from an existing overhead powerline on the west side of State Highway No. 9. Power will be supplied to the sanitary landfill site by an underground cable which will be installed as part of construction of the permanent access road.

Domestic Water

Domestic water, including water for fire protection, is available from the existing waterline along State Highway No. 9. Domestic water supply and fire flow will be supplied by a four and six-inch pipe constructed in association with the permanent access road.

Telephone

Telephone service is available from existing facilities located along State Highway No. 9. Telephone lines to the site would be installed by the General Telephone Company.

Table 2

Utilities Required at Cathcart Site

Location on Site	Power	Yard Lights*	Domestic Water	Fire Hydrant & Water Line	Telephone	Radio	Other
Gate House & Scale	Yes	Yes	No	Yes	Yes	No	
Office & Employee Building	Yes	Yes	Yes	Yes	Yes	Yes	Septic tank and drainfield
Vehicle Storage Shed	Yes	No	Yes	No	No	No	
Collection Vehicle Wash Facility	No	Yes	Yes	No	No	No	Septic tank and drainfield
Waste Disposal Area (near working face)	No	Yes	No	Yes	No	Yes	Portable toilets
Leachate Treatment Facility	Yes	Yes	Yes	No	No	No	

*Light on pole or building light with switch boxes.

Radio

Snohomish County has a radio system to which operations at the landfill site may be connected. It is proposed that radio communications be established between the locations shown on Table 2 to facilitate the communication required for the operation of the landfill.

Other Utilities

A septic tank and drainfield will be installed for the disposal of wastewater from the office and employee building and the collection vehicle wash facility. Prior to construction, a drainfield area must be selected and percolation tests must be performed. The septic tank and drainfield should be designed and constructed in accordance with Manual of Septic Tank Practice, U. S. Department of Health, Education and Welfare, Public Health Service, latest edition and the standards and criteria promulgated by Snohomish County Health District.

If a suitable drainfield site is not available in the immediate vicinity of the facilities, a site within reasonable piping distance from the facilities must be selected. Drainfield sites along the hill east of the holding pond area and creek should be avoided. Areas east and southeast of the proposed facilities should be investigated. A temporary drainfield could be established in the southern end of the waste disposal area until the area is excavated, at which time the wastewater could be piped to drain into the leachate collection system.

A portable toilet of the type generally used at construction sites should be supplied at the waste disposal area near the working face. The waste accumulated in the portable toilet will have to be pumped periodically and can be dumped in the leachate lagoon.

Drainage and Pollution Control Facilities

The drainage and pollution control facilities are shown on Sheets 3 through 12 in Appendix C. The facilities consist of off-site surface water runoff detention and diversion facilities, on-site surface water runoff diversion and treatment facilities, and leachate collection, treatment and disposal facilities.

Off-Site Surface Water Runoff Facilities

The purpose of the off-site surface water runoff detention and diversion facilities is to maintain or improve water quality and use of the intermittent creek that presently runs through the proposed waste disposal area by:

- Intercepting and diverting surface water from south and west of the waste disposal area around the disposal area and back into the natural creek channel north of the disposal area.

- Reducing stream flows during storms.
- Detaining storm flows to allow settlable materials to settle out of the stream water. Occasional maintenance dredging will be required to remove settled material from the holding pond. Dredged material can be stockpiled and/or wasted on-site.
- Storing late spring storms for maintaining stream flow during a portion of the normally dry summer months.
- Adding no new stream blockages.
- Providing basic facilities that could later be modified for use in a park setting.

The detention and diversion facilities were designed for the 100-year, 60-minute storm using the rational formula:

$$Q = CIA$$

where

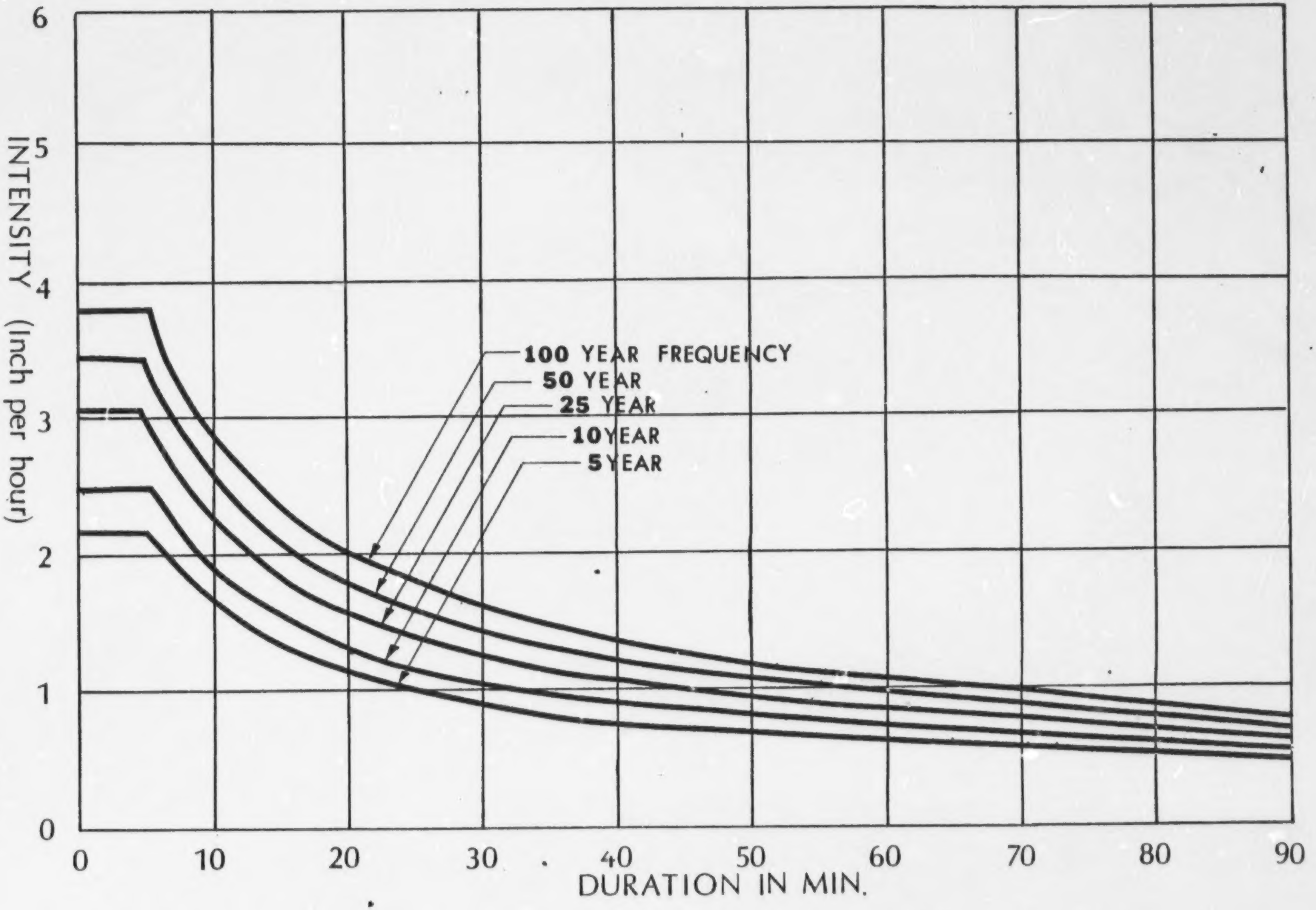
Q = design flow (cfs)
C = coefficient of runoff (dimensionless)
I = rainfall intensity (inches/hour)
A = drainage area (acres)

The coefficient of runoff has been assumed to be 0.3 which is typical for hilly, unimproved areas.

Rainfall intensity is assumed to be dependent on storm duration (time of concentration) and the design storm frequency as shown in Figure 3. The nomograph in Figure 4 was used to establish the time of concentration for small drainage basins. The time of concentration for the drainage area (approximately 420 acres) contributing to the proposed holding pond at the south end of the Cathcart site is 60 minutes.

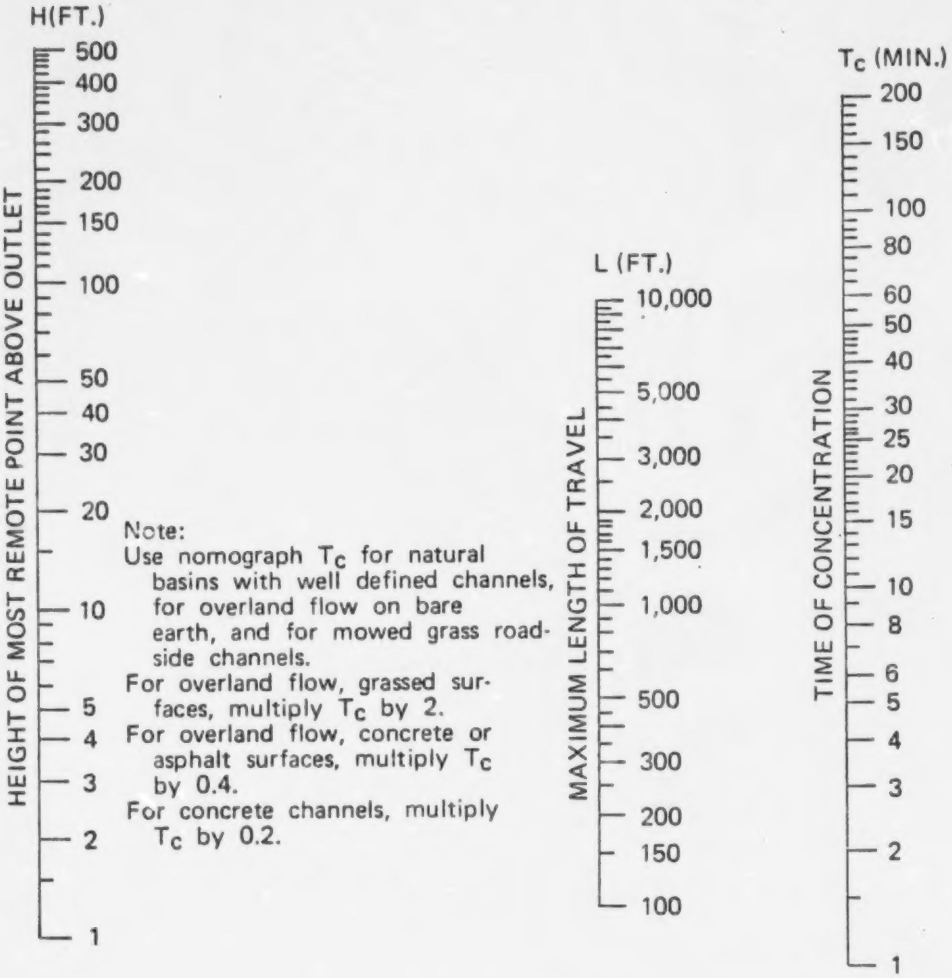
The 100-year storm design flow for off-site surface runoff into the holding pond is estimated to be 140 cubic feet of water per second, using the rational formula. To minimize the effect of this relatively high flow on the diversion channel and downstream natural channel, the holding pond outlet weir has been designed to reduce the 100-year storm flow to 80 cubic feet per second which is equivalent to a 5-year, 60-minute storm flow. Regulating the downstream flows during the 100-year storm to flows lower than 80 cfs would require a higher dam for the holding pond and the water level would inundate more land area south of the proposed holding pond site.

The holding pond will be formed by constructing an earth dam across the existing creek channel and excavating south of the dam to provide a pond even during times of no upstream flow (permanent water level). A weir



RAINFALL INTENSITY DURATION FREQUENCY

Figure 3



Note:
Use nomograph T_c for natural basins with well defined channels, for overland flow on bare earth, and for mowed grass roadside channels.
For overland flow, grassed surfaces, multiply T_c by 2.
For overland flow, concrete or asphalt surfaces, multiply T_c by 0.4.
For concrete channels, multiply T_c by 0.2.

TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS

Figure 4

with a 6 ft. wide by 3 ft. high control section will regulate downstream flow. A terrace around the perimeter of the pond is necessary for maintenance of the pond and public safety.

Details for the holding pond, dam and outlet weir are shown on Sheet 12 of Appendix C. The upstream face of the dam and the pond bottom and sides will be lined with impervious soils to minimize seepage of water into the waste disposal area north of the dam. The sides of the waste disposal area will later be lined with a leachate barrier which will provide additional protection against water seepage. Characteristics of the proposed holding pond and weir at the various design water level elevations are listed in Table 3.

Design criteria for the outlet weir of the holding pond includes:

- o Maintain minimum water level in the pond at elevation 307.0 feet.
- o Control discharge to 80 cfs at water level elevation of 310.0 feet.
- o Provide an emergency spillway into the diversion channel that will discharge a minimum of 140 cfs at water level elevation 311.0 feet.
- o Weir height should be adjustable between elevations 307.0 and 310.0 feet.
- o Weir with height at elevation 307.0 feet should not block the stream.

Table 3

Characteristics of Proposed Off-Site Runoff Holding Pond

1.	Water Surface Elevation (Ft.)	307.0	310.0	311.0
2.	Total Pond Volume (Cu. Ft.)	174,000	306,000	-
3.	Storage Volume above Elevation 307.0 feet (Cu. Ft.)	0	132,000	-
4.	Pond Surface Area (Acres)	0.8	1.5	-
5.	Depth of pond; range (Ft.)	4 to 8	up to 11	up to 12
6.	Freeboard to top of Dam at Elevation 312.4 feet (Ft.)	5.4	2.4	1.4
7.	Discharge at weir (cfs)	0	80	150

Design criteria for the holding pond includes the following:

- o Minimum water depth at permanent water level should be 3 feet to prevent growth of weeds plus 1 foot additional depth for sediment accumulation.

- Side slopes should be no steeper than 3H:1V for slope stability and no steeper than 4H:1V for grassed areas that will be mowed.

- A terrace, located one foot above permanent water level, should be 12 feet minimum width for equipment access and 5 feet minimum width for walkway purposes.

- The terrace and areas above the terrace should be seeded with grass for slope stability and aesthetic purposes.

- The pond should have 130,000 cu. ft. storage capacity between elevations 307.0 and 310.0 feet.

- Pond bottom and sides up to elevation 308.0 feet should be lined with an impervious material as the site is less suitable for construction of a dam with an impervious core.

- Minimum freeboard of 2 feet should be provided for the 100-year storm.

The diversion channel will be constructed from the holding pond outlet weir, along the southern and western sides of the permanent site road and then down the steep hill to the natural creek channel at the north end of the site as shown on Sheets 3 and 12 of Appendix C. Total length of the proposed diversion channel is approximately 3,560 feet which is equal to the length of natural channel bypassed by the diversion channel.

The final 240 foot downstream segment of the diversion channel is very steep (approximately 30% slope). A 4-foot wide concrete chute with a concrete stilling basin at the natural stream channel has been selected as the type of channel for withstanding the large velocities and erosion. An open channel was considered to be more consistent with future use of the site than a pipe. Another option that could be considered is a series of waterfalls.

A trapezoidal channel section with 2H:1V side slopes and with chemically stabilized and grassed bottom and sides was selected for segments with gentle grades in the 0.10 to 0.14% range to minimize erosion in the easily eroded soils and to minimize construction costs. A manning roughness coefficient of 0.025 was assumed. Channel lengths are approximately 1,460 feet of 4 feet wide channel, 130 feet of 6 feet wide channel, and 180 feet of 8 feet wide channel.

A trapezoidal channel section with 2H:1V side slopes and with rock riprap along the bottom and sides was selected for steeper segments with grades up to 6% and for transition areas. A manning roughness coefficient of 0.035 was assumed for 1 foot nominal rock diameter and 0.038 for 2 foot nominal rock diameter. Channel lengths would be approximately 1,380 feet of 4 feet wide channel, 50 feet of 6 feet wide channel, and 120 feet of transitions between different channel widths.

A culvert will be required at the access road to the permanent excess soil stockpile area. Two 48-inch diameter corrugated metal pipe or two 42-inch diameter concrete pipe would be required to pass the 140 cfs flow without backing the water up over the road base. The pipes could be installed when the diversion channel is constructed or during the summer prior to construction of the excess soil stockpile area.

Design flows for the diversion channel were 140 cfs and 80 cfs. The channel should be able to carry 140 cfs with 1 foot minimum freeboard to the top of the permanent site road base without causing excessive damage. Maximum permissible velocities of 15 feet per second in rock riprap (2 feet nominal rock diameter) channels or 5 feet per second in chemically stabilized and grass-lined channels would be allowed. Some overflows into suitable sections of the buffer area may be allowable, but will be determined after final survey.

The diversion channel should be able to carry 80 cfs without overflow into the buffer area and velocities should not exceed 10 feet per second in rock riprap channels or 3 feet per second in chemically stabilized and grass-lined channels.

A computer program for backwater analysis was run for the diversion channel profile and sections indicated on Sheet 12 of Appendix C to check the design concept. Results indicated that a 5 foot channel depth was adequate for the 140 cfs design flow and that velocity criteria could be met. After the channel route is surveyed, the design of the concrete chute and stilling basin can be finalized and design of the trapezoidal channel segments can be finalized to minimize excavation depths and rock riprap.

On-Site Surface Water Runoff Diversion and Treatment Facilities

The on-site surface runoff diversion and treatment system is shown in Appendix C. During operation of the landfill, the system will consist of a pipe collection system located under the fill. These pipes will be placed in trenches excavated into the underlying sandstone or dense glacial till. The trenches will be backfilled with the most impervious on-site soils available and the top of the trenches will be covered with the leachate barrier to prevent leachate from entering the pipe.

The collection system will be developed in stages as indicated on Sheets 13 through 20 in Appendix C.

This collection system will convey the on-site surface runoff to a settling pond prior to discharge to the existing drainage channel north of the site. When landfill operations are completed, the runoff will drain into a ditch on the east side of the permanent access road. This ditch will also discharge into the settling pond prior to discharge into the existing creek channel. The underground pipe system will then be diverted into the leachate collection system in event that the abandoned pipeline ever starts to collect leachate.

The piping system and ditch are designed to accommodate the 10-year storm at a runoff coefficient of 0.2 over 80 acres. This results in a design flow of 17 cubic feet of water per second. The settling pond is designed to provide for 10 days detention time at an annual average rainfall of 45 inches over 365 days which results in a volume of 360,000 cubic feet.

The on-site surface runoff settling pond will be constructed by installing a small dam across the existing creek channel north of the site. Treated runoff will be discharged through an 18-inch corrugated metal pipe to the existing creek channel north of the site.

Leachate Collection, Treatment, and Disposal Facilities

The leachate collection, treatment, and disposal facilities consist of the following components:

Leachate barrier
Leachate collection system
Raw leachate pumping system
Aerated lagoon
Physical chemical treatment system
Outfall

Soil tests of the south end of the site indicate that the dense sandstone could provide a natural barrier to movement of leachate or gases out of the waste disposal area or to reverse movement of groundwater into the disposal area. However, detailed soils tests have not been conducted in the northern and western portion of the waste disposal area to confirm this conclusion. Therefore, the following approach has been chosen for providing a leachate and gas barrier along the bottom and sides of the waste disposal area.

1. The bottom and sides of the fill area will be lined with a leachate barrier material that will have a permeability less than 1×10^{-8} cm/sec, and will not be degraded by leachate or gases for a minimum of 40 years. The leachate barrier material will also not be susceptible to damage by vehicle traffic or solid waste materials. Methods being considered include membrane liners (i.e. PVC), asphaltic concrete, clay liners, and a chemical resin that stabilizes and seals the surface soils. Protective layers of sandy soils would be placed over the membrane, clay or chemical resin liners. The leachate barrier will extend up to the top of the road berm along the south and west sides of the fill area, and will extend a minimum of 15 feet vertically up the excavated eastern and northern side slope. The barrier material will be selected after subsurface soils investigations are completed in the northern and western ends of the fill area.

2. The northern and eastern side slopes in the excavated fill area will be sealed with the chemical resin material (or other appropriate material) wherever the excavated soils have a permeability greater than 1 x 10^{-5} cm/sec. This will be necessary to seal porous soil lenses to force leachate to drain to the bottom of the fill area and to provide a gas barrier. A layer of gravel will be placed along the northern, western and eastern side slopes to allow unrestricted movement of leachate and gas. Most leachate should drain away from the eastern side slope as the top surface of each lift will drain to the west.

3. The bottom of the fill area will be excavated to drain the shortest distance (east and west) to the center of the fill area which will be sloped to drain to the northern end. A perforated pipe covered with a berm of gravel will be placed along the center drainage (from south to north) to provide positive drainage to the leachate collection system at the north end of the fill area. This will minimize the depth of leachate accumulation in the fill area and will minimize leachate loss should a local area of the leachate barrier fail.

The unweathered sandstone, underlying the site, could be used as a natural leachate barrier provided that fractured areas can be identified and sealed and provided that the excavated or repaired surface has a permeability less than 1 x 10^{-8} cm/sec. Soils testing to date indicate a high probability that the unweathered sandstone will meet the above requirements. However, additional subsurface soils investigations in the northern portion of the waste disposal area will be required as an intermediate step to verify the sandstone as a natural leachate barrier. Also, a large area of sandstone should be exposed by excavation to inspect for fractures, determine the feasibility and reliability of sealing fractures, and to finalize the design selection.

The excavation depths and grades presently specified in Appendix C are expected to expose some sandstone across the northern end of the stage 1 area. However, much of the waste disposal area will be excavated only into glacial till and other porous soils overlaying the dense sandstone. The till and other porous soils will require a layer of leachate barrier material to prevent leakage of leachate out of the waste disposal area. If the unweathered sandstone proves to be an adequate natural leachate barrier, it would be possible to modify the depths and grades along the bottom of the waste disposal area to excavate through the porous soils into unweathered sandstone. This would increase landfill life by approximately one year, increase excess soil quantities by approximately 160,000 cubic yards, and may substantially reduce cost of the leachate barrier.

The leachate collection system is shown in Sheets 7 and 8 in Appendix C. The leachate collection system consists of an eight-inch perforated pipe placed in a trench excavated into the sandstone. The trench will be lined with an impervious membrane liner to prevent leakage of leachate into the sandstone and will be backfilled with gravel. The side cut at the north toe of the landfill will be sealed with an impervious material to prevent leachate from escaping the landfill to the north. The bottom of the fill area will be sloped to drain leachate to the leachate collection system.

The leachate collection system will drain to the leachate pump station located at the low point on the northern periphery of the waste disposal area.

The pump station will have a capacity of fifty gallons per minute at approximately twenty-five feet of total dynamic head, and will discharge through a four-inch diameter force main into the aerated lagoon.

The pump station will be a factory-fabricated, package type and will include two submersible pumps, each capable of handling the entire design flow.

The leachate treatment facility must provide adequate treatment to allow effluent discharge to the on-site surface runoff holding pond and eventually to the existing creek north of the site. To meet this requirement, the average concentration of specific effluent constituents should not exceed the following:

Biochemical Oxygen Demand	5 mg/l
Suspended Solids	5 mg/l
Chemical Oxygen Demand	10 mg/l
Phosphates (as phosphorus)	1 mg/l
Total Coliform Bacteria	20/100 ml
pH	within limits of 6.0 to 9.0

Based on this, the leachate treatment facility should consist of the following units:

Aerated Lagoon
Flash mixing unit with chemical addition
Flocculation unit
Sedimentation unit
Activated carbon reactors
Pressure filter
Chlorine contact chamber
Dechlorination unit (activated carbon)
pH adjustment unit
Sludge holding tank

The following are specific design criteria for each of the units:

Aerated Lagoon	
Design BOD removal	80-85%
Detention Time	11 days
Oxygen requirement	1.5 lbs O_2/lb BOD
Aerator oxygen transfer	2 lbs O_2/HP hr.
Flash Mixing Unit	
Detention time	60 seconds
Flocculation Unit	
Detention time	20 minutes
Sedimentation Unit	
Overflow rate	600 gpd/sf.
Detention time	2 hours
Weir rate	1,000 gpd/LF
Activated Carbon Reactors	
Hydraulic loading	2 gpm/sf.
Pressure Filter	
Hydraulic loading	3 gpm/sf.
Chlorine Contact Chamber	
Detention time	60 minutes
Dechlorination Unit	
Same as activated carbon reactors	
pH Adjustment Unit	
Detention time	60 minutes
Sludge Holding Tank	
Storage capacity	15 days

All units, except the aerated lagoon and the sludge holding tank, can be supplied as a package treatment plant by one manufacturer. A site layout and schematic flow diagram of the leachate treatment facility are shown on Sheet 10 in Appendix C.

The aerated lagoon is designed to provide 80 to 85 percent removal of Biochemical Oxygen Demand (BOD). It has previously been assumed that the influent BOD will average 2,000 milligrams per liter. This will result in an effluent BOD concentration of 300 to 400 milligrams per liter, primarily as suspended solids.

The lagoon will be constructed prior to landfill operations and will have a volume of 400,000 gallons. This will correspond to a detention time of 11 days at a flow of twenty-five gallons per minute.

The aerated lagoon will be an earthen basin sealed with an impervious membrane. The aerator will be twenty horsepower, highspeed floating unit, based on an oxygen transfer rate of two pounds of oxygen per horsepower-hour, and an oxygen requirement of 1.5 pounds of oxygen per pound of BOD.

Generally, leachate does not have adequate nutrients for proper biological treatment. If this is the case at Cathcart, consideration should be given to the addition of nutrient feeding equipment to optimize the operation of the aerated lagoon.

The effluent from the aerated lagoon will be pumped to the package treatment plant discussed previously. This package plant will require a surface area of approximately 37 feet by 10 feet. It is recommended that the package plant be housed in a 48 feet by 16 feet building. This would provide covered storage for chemicals, aerated lagoon, and leachate pump station motor control center and sludge holding tank. The sludge holding tank will be periodically emptied and the sludge will be wasted with the solid waste.

The chemicals to be utilized in the flocculation-sedimentation part of the leachate treatment plant would have to be determined from actual analyses performed on the aerated lagoon effluent.

The effluent from the pH adjustment unit of the package treatment plant will be discharged to the on-site surface runoff ditch through an eight-inch outfall pipe. The treated leachate will receive further treatment (at least ten days detention time plus dilution) in the on-site surface runoff holding pond prior to discharge to the existing creek north of the landfill site.

Water Quality Monitoring Program

Baseline monitoring will be conducted at groundwater monitoring wells and on the creek flowing through the Cathcart site to document water quality characteristics prior to landfill development and operation. Ground and surface water monitoring that is currently being conducted by Department of Ecology (DOE) at six locations shown in Figure 1 will provide part of the required baseline information. Data on fecal coliform, pesticides, oil and grease, and stream sediment samples should be obtained to complete the baseline data requirements.

Routine monitoring will be accomplished throughout the operation of the landfill and should not be discontinued until it can be positively proven that the generation of leachate has ceased. Routine monitoring would be conducted at six groundwater monitoring wells and four stream monitoring stations (refer to locations on sheet 2 of Appendix A), the leachate treatment facility and the on-site runoff settling pond. All on-site monitoring should be performed by Snohomish County Department of Public Works and the data should be submitted to the Snohomish Health District for review. All tests should be performed in accordance with Standard Methods for the Examination of Water and Wastewater, latest edition, published by the American Public Health Association.

The Snohomish Health District should periodically monitor private wells in the vicinity of the Cathcart site for materials indicating the presence of leachate (i.e. chloride and sulfate). The wells within one mile of the waste disposal area are indicated on Sheet 1 of Appendix C and in the Final Environmental Impact Statement - Cathcart Sanitary Landfill.

The purpose of the water quality monitoring program is to detect changes in the environmental conditions at and surrounding the site in its early stages and provide a sound basis for implementation of remedial measures before the changes become uncontrollable. The recommended scope for each part of the program are described in following paragraphs. It may become necessary to modify the scope of monitoring at a later date based on data trends observed after the first few years of monitoring. Large quantities of high strength leachate are not expected until after one to three years of landfill operation.

Groundwater Monitoring Wells

Two of the monitoring well locations used for current DOE sampling program (locations 1 and 6 on Figure 1) are used in the monitoring well network shown in Appendix C. The other DOE well locations would be destroyed by development of the waste disposal area or are not located to intercept groundwater flow from the waste disposal area.

Baseline monitoring should be conducted for at least one year prior to operation of the sanitary landfill. Parameters to be monitored should include materials found in leachate which are moderately to highly mobile in subsurface soils and materials which are important to water quality for agricultural (irrigation and livestock) and domestic water uses. The following parameters and sampling frequency are recommended for baseline monitoring of groundwater wells:

Monthly Sampling (One Year Baseline)

pH*
Color*
Total Solids*
Total Volatile Solids*
Total Dissolved Solids*
Conductivity*
COD*
Total Hardness*
Chloride*
Sulfate*
Nitrate & Nitrite (as N)*

Ammonia (as N)*
Total Phosphorus
Total Coliform*
Fecal Coliform*
Sodium*
Potassium*
Calcium*
Manganese*
Iron*

Quarterly Sampling

Cadmium*
Chromium*
Copper*
Lead*
Mercury
Nickel*
Zinc*

*Has been monitored by D.O.E. and should be used for baseline.

Routine monitoring of groundwater wells would be conducted for materials that would indicate leakage of leachate out of the waste disposal area. The wells would be sampled monthly for conductivity, chloride, sulfate, sodium, and calcium which represent leachate materials that are mobile in soils.

If routine monitoring indicates the presence of leachate (significant increase in indicator materials) in wells outside the waste disposal area, then other monitoring may be necessary to isolate the source and quantify the extent of the problem.

Stream Monitoring Stations

One of the surface water monitoring stations (location 3 on Figure 1) currently used by DOE will be used in the stream monitoring network shown in Appendix C. The other DOE locations will not be suitable after diversion of the creek.

Baseline monitoring should be conducted for at least one year prior to extensive clearing and earthwork at the DOE monitoring locations. Parameters to be monitored should include the materials expected in leachate and on-site surface runoff, the parameters used in the Department of Ecology Water Quality Standards for Class A streams, and materials which are important to water quality for agricultural, domestic, aquatic life, and aesthetic water uses. Sediment samples should also be taken from a location where sediment deposition downstream of the waste disposal area would be expected in future years. A benthic survey would be most useful to monitor long-range impacts on the creek. The University of Washington should be contacted to determine their interest in developing and conducting a series of benthic surveys on the creek.

The following parameters and sampling frequency are recommended for baseline stream monitoring:

Monthly Sampling (One Year Baseline)

Flow
Temperature
Turbidity*
Color*
Conductivity*
Total Solids*
Total Dissolved Solids*
Suspended Solids*
Total Volatile Solids*
pH*
Dissolved Oxygen
Total Coliform*
Fecal Coliform
Nitrate & Nitrite (as N)*

Ammonia (as N)*
Organic Nitrogen (as N)
Total Phosphorus (as N)
BOD
COD*
Chloride*
Sulfate*
Sodium*
Potassium*
Calcium*
Magnesium*
Manganese*
Iron*
Oil & Grease

Quarterly Sampling

Cadmium*
Chromium*
Copper*
Lead*
Mercury
Nickel*
Zinc*
Chlorinated Hydrocarbons

*Has been monitored by D.O.E. and should be used for baseline.

The following parameters are recommended for sampling of sediments every two years: total solids, total volatile solids, heavy metals (Cd, Cr, Cu, Pb, Hg, Ni, Zn), and pesticides.

Routine monitoring of the creek would include a sampling at station S-1, concurrently with sampling of discharge from on-site surface runoff settling pond, to determine the impact of treated wastewaters on the creek plus monitoring of the creek upstream and downstream of the waste disposal area for materials that would indicate leakage of leachate or on-site surface runoff into the creek.

The following parameters and sampling frequency are recommended for routine monitoring at station S-1:

Quarterly

All baseline stream monitoring parameters except heavy metals and chlorinated hydrocarbons which would be sampled once in summer and once in fall.

Monthly

Stream flow
pH
Temperature
Turbidity
Dissolved Oxygen
Color
Conductivity
Total Coliform
COD
Chloride
Sulfate

The following parameters are recommended for routine sampling every month at Stations S-2, S-3 and S-4: pH, temperature, turbidity, dissolved oxygen, color, conductivity, total coliform, COD, chloride and sulfate.

If routine monitoring indicates leakage of leachate or on-site surface runoff into the diverted creek, investigations necessary to define the problem should be undertaken.

The sediment sample should be taken every two years from the same location.

Treatment Facilities Monitoring

Monitoring of treatment facilities should include the on-site surface runoff settling pond influent and effluent, raw leachate, aerated lagoon effluent, and completely treated leachate prior to discharge into the settling pond. The purposes of this monitoring is to measure the effectiveness of the treatment facilities and to monitor discharges to the creek for verification of discharge requirements.

The following parameters and sampling frequency are recommended to provide research data for evaluating performance of unit operations, if a funding source becomes available. Parameters necessary for basic operational control are noted, and should be routinely monitored as a minimum requirement.

Monthly Sampling

Flow*
Temperature
Color*
Turbidity*
Total Solids
Total Dissolved Solids
Total Suspended Solids*
Total Volatile Solids
pH*
Dissolved Oxygen
Oil & Grease
Nitrate (as N)*
Nitrite (as N)
Ammonia (as N)*
Organic Nitrogen*
Total Phosphorus*
Ortho Phosphate (as P)
Total Coliform*
Fecal Coliform*
BOD*
COD*
Chloride
Sulfate
Sodium
Potassium
Calcium
Magnesium
Manganese
Iron
Conductivity*

Quarterly Sampling

Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Zinc
Chlorinated Hydrocarbons

*Routine monitoring for operational control.

The following parameters are recommended for weekly sampling of discharge from the on-site surface runoff settling pond: flow, BOD, COD, suspended solids, total coliform, pH, total phosphorous, total nitrogen, dissolved oxygen, chloride, sulfate, color and conductivity.

Gas Control Systems

Gases will be allowed to move laterally through the landfill by the construction of gravel-filled ditches at the highest point of each daily cell. The gas from the entire fill will be collected through a gravel wall on the north, east and west side of the fill, as shown on Sheets 15 and 16 in Appendix C. The top of the gravel wall will be sealed with impervious soils to keep water out of the landfill. Vents to the atmosphere will be installed through this impervious seal along the east and west sides of the fill area.

Gas vents are sized to handle 10% of total gas generation within one year as a peak rate at a velocity of 1 foot per second. Gas generated over the total degradation cycle is estimated at 12 billion cubic feet at one atmosphere of pressure based on 15 cubic feet per second of volatile solids, 35% volatile solids and total landfill capacity of 1,140,000 tons of waste.

If the release of gases to the atmosphere results in a significant odor problem, the installation of a gas header and burners should be considered.

Landfill Equipment

Equipment will be required for two distinct operations in the general waste disposal area; (1) site preparation, including excavating and stockpiling cover material, and (2) cell development, including moving and compacting waste and cover to form the cell. The equipment required for the site preparation operation will be used on an intermittent basis for a few months as each landfill stage is prepared. Large quantities of earth will be excavated and stockpiled. Equipment required will include large track-type tractors with rippers for excavation, large scrapers, graders and equipment necessary for construction of pipeline, ditches, roads, earthen dams, and the leachate barrier.

The daily landfill operation will require a large sized track-type tractor modified for landfill operations or a landfill compactor. A second tractor would be utilized on large waste load days and a medium sized scraper would be used to transport daily cover material.

The availability of a water truck would be required during dry-weather operations for dust control. It is also desirable to have a truck-mounted litter vacuum available for site maintenance and litter control. A general maintenance half-ton truck should be available.

Buffer Zone and Reserve Areas

The purpose and general requirements for the buffer zone are discussed in Appendix A. Since a large part of the vegetation on the site consists of alder, additional evergreen trees and shrubs will be required to obtain the desired screening effect. The extent of additional planting will be determined by the county after the site is cleared.

The buffer zones and reserve areas are shown on Sheet 1 in Appendix C. The buffer along the east side of the landfill would be approximately 180 feet wide. This buffer zone would be left in its natural condition with the addition of planting of evergreens and shrubs as required.

The buffer along the west side of the landfill is approximately 200 feet wide to the center of the permanent access road. This area would contain the access road and the drainage diversion channel. The remaining width of 100 to 150 feet, depending upon depth of channel cuts, would be left in its natural condition. Since there are no homes on the west side of the landfill, planting of additional vegetation in the west buffer zone may not be rquired.

Considerable reserve area, approximately 110 acres, has been designated for the total 200 acre Cathcart site. The southeastern 40 acre area of the site presently contains a residence and out buildings. The area would be left in its present condition, except for the access road and service facilities along the access road, such as the scale, gate house, collection vehicle wash facility and employee and office facility. Trees in this area must be retained, wherever and whenever possible, to provide screening. For future development of the site, this area would be physically suitable for buildings, bulky waste disposal and special facilities such as resource recovery. The area would be less suitable for general or special waste disposal because of proximity to the highway and residences and subsurface soil conditions.

Approximately 7 acres directly south of the landfill area would be used for stockpiling cover materials during landfill operations. In the future, the landfill operation could be extended into this area or the area could be developed as part of the future use plan and not be filled with waste.

Approximately 40 acres at the north end of the proposed landfill area would be reserved in its natural condition, except for very limited development in the vicinity of the on-site surface runoff settling pond and leachate treatment facilities.

Fencing

Fencing locations will be determined by the county after the site is cleared. Six-foot high chain link fence with three strands of barbed wire on top should be considered along the eastern side of the waste disposal area for litter control and because of deep cuts. The rest of the waste disposal area perimeter should be enclosed with a six-foot high wire mesh fence for litter control and to provide a barrier to animals and people. This fence should be installed between the site road and the creek diversion channel to keep litter out of the creeks, and should also enclose both holding ponds. A wooden fence or chain link fence with wooden slats should be considered along the southern property line for approximately 1,100 feet to help reduce noise impact on the existing mink farm.

Warning signs will be posted on the fence at intervals governed by local topography. An access gate with lock will be provided at the entrance from State Highway No. 9.

Future Considerations

Possible facilities to be added at a future date include nutrient feeding equipment for the aerated lagoon and gas header and burners. These facilities would be designed from data obtained during operation of the landfill over an extended period of time.

SITE DEVELOPMENT SEQUENCE

General Approach

The Cathcart site will be developed, operated and prepared for future use in three separate phases, as outlined in Table 4. In Phase I, the site will be prepared for receiving solid wastes through a three-stage approach which will include, 1) clearing, surveying, subsurface soils investigation and water quality monitoring, 2) finalization of design, and 3) initial site construction.

In Phase II, a sanitary landfill operation will be conducted in the 56-acre waste disposal area which will be filled to final contours and elevations in six stages over an estimated time period of approximately seven years. The sanitary landfill operation will start at the north end of the waste disposal area, as indicated on Sheet 13 in Appendix C.

In Phase III, the site will be maintained after the sanitary landfill operation has ceased and the site will be planned and prepared for final use. Development for final use may be accomplished during later stages of the sanitary landfill operation, as portions of the 56-acre waste disposal area will be developed to final contours and elevation as soon as possible.

Table 4

Cathcart Site Development Sequence

PHASE I: INITIAL SITE PREPARATION

Stage 1 - Initial Site Preparation - Clearing and site investigations.
Stage 2 - Construction Plans and Specifications
Stage 3 - Initial Site Construction

PHASE II: SANITARY LANDFILL OPERATION

Stage 1 - Landfill and Stage 2 Preparation
Stage 2 - Landfill and Stage 3 Preparation
Stage 3 - Landfill and Stage 4 Preparation
Stage 4 - Landfill and Stage 5 Preparation
Stage 5 - Landfill and Stage 6 Preparation
Stage 6 - Landfill

PHASE III: FINAL USE

Stage 1 - Maintenance and operation after landfill closure
Stage 2 - Final use development

Phase I - Initial Site Preparation

It will be necessary to prepare the first portion of the waste disposal area for receiving solid wastes and to construct the related site facilities in three stages. Clearing must be accomplished as a first step to open up portions of the site for survey and subsurface soils investigations in the northern and western sides of the site. The survey and soils information are required to allow finalization of the design of the various site use facilities. The last stage of Phase I will be preparation of the waste disposal area and construction of facilities required to initiate the sanitary landfill operation.

Stage 1 - Site Preparation - Clearing and Site Investigations

Clearing: Approximately 54 acres of the Cathcart site will be logged, cleared and grubbed in the locations shown on Sheet 2 of Appendix C. Areas reserved for buffer zones and reserve areas must not be disturbed.

Prior to the clearing operation, the county should: 1) obtain approval from the State of Washington Department of Natural Resources (owner) to use the site, 2) obtain a logging permit from the Department of Natural Resources, and 3) advertize and award a contract for logging, clearing and grubbing. Other permits may be necessary depending upon methods used by the contractor.

The construction period for the clearing contract should be approximately 90 days. Construction supervision should be performed by Snohomish County.

Final Design Survey: Because of inaccessibility and heavy vegetation, design surveys have not yet been performed on portions of the landfill site. The site preparation discussed above will provide the necessary accessibility to complete the design survey in these areas. Areas of particular concern include portions of the site to be utilized for initial landfill operations, the on-site surface runoff holding pond area, the leachate treatment facilities area, the permanent road, and the off-site surface runoff diversion channel route. Other areas where additional surveys may be needed will be defined during finalization of design.

The final design survey can begin whenever the areas of concern have been cleared. The final design surveys should be performed by personnel from Snohomish County.

The final design survey should also include an analysis, by Snohomish County Department of Public Works, of screening capacity of the buffer zones and reserve areas. A noise consultant should be retained and noise abatement regulations being adopted by Department of Ecology, should be considered. The analysis would determine the visual screening and noise attenuation capacity of the buffer zones and reserve area and would determine the extent of new planting in these areas to obtain the desired screening capacity.

Subsurface Soils Investigation: Heavy vegetation has prevented soils investigations from being conducted on the northern portion of the site. Areas of concern include:

- Waste Disposal Area: Landfill Stages 1, 2 and part of 3 should be investigated to determine soil conditions to dense sandstone, location of dense sandstone and groundwater, and permeability of sandstone.
- On-Site Runoff Holding Pond: The location for the dam requires investigation for soil types, depth to bedrock, bearing capacity of bedrock, and soil permeability.
- Off-Site Runoff Holding Pond: The location for the holding pond requires similar investigations as for the on-site holding pond dam.
- Off-Site Runoff Diversion Channel: The location where the channel joins the natural streambed needs to be investigated for soil types and depth to bedrock.
- Leachate Treatment Facility: The location of the leachate lagoon and treatment plant requires investigation for soil type and bearing capacity.
- Permanent Site Road: The road location along the western side of the waste disposal area should be investigated for soil type, groundwater location, and hard sandstone location to determine the feasibility of using the off-site runoff drainage channel for intercepting groundwater movement towards the waste disposal area.

The above soils investigations should be accomplished after the various areas have been cleared and surveyed.

Water Quality Monitoring: Six groundwater monitoring stations around the waste disposal area, a stream monitoring station downstream of the waste disposal area and three stream monitoring stations along the disturbed area should be installed, as shown on Sheet 2 of Appendix C, to monitor water quality during site construction, landfill operation and landfill maintenance after the waste disposal operation has ceased.

Baseline water quality conditions should be established over at least a one year period. The baseline stream monitoring should be initiated prior to site clearing and/or any extensive site development work near the stream. The baseline groundwater monitoring should be initiated as soon as possible after the site has been opened up enough to allow installation of the groundwater monitoring wells.

Water quality monitoring should be performed by the Snohomish County Department of Public Works.

Stage 2 - Site Preparation - Finalization of Design

Finalization of design will include development of final construction features and requirements of the following elements:

- Earthwork in waste disposal area - excavation, grading and stockpiling
- Earthwork for permanent access road - cut, fill, and rough grades
- Groundwater monitoring wells (per recommendations of Snohomish Health District)
- On-site water quality monitoring
- Leachate collection, treatment and discharge facilities
- Leachate barrier
- On-site runoff drainage and holding pond
- Off-site runoff drainage and holding pond
- Gas controls and monitoring
- Final cover on landfill
- Access at Highway 9
- Permanent site roads - final grades, surfacing and maintenance
- Fencing
- Buffer zones and reserve areas
- Buildings and related site preparation
- Scale
- Utilities
- Overall site operations - including sanitary landfill operation (per regulations and review recommendations of Snohomish Health District)

Stage 3 - Site Preparation - Initial Site Construction

Facilities to be Constructed: Facilities to be constructed during this stage, shown on Sheets 3 through 12 in Appendix C, include the following:

- Site entrance at State Highway No. 9
- Permanent Site Road
- Buildings
    - Gate house and scale
    - Employee and office building
    - Vehicle storage shed
- Utilities - power, outdoor lighting, water supply, telephone, radio, septic tank and drainfield, and portable toilet facility.
- Buffer
    - Screening
    - Fencing
- Preparation of Stage 1 Landfill Area
    - Excavation and grading
    - On-Site runoff drainage pipeline
    - Leachate collection pipeline and pump station
    - Leachate barrier on bottom and sides
    - Gas venting gravel layer on east and west sides
    - Temporary access road
- Preparation of Stage 2 Landfill Area
    - Excavation and rough grading for drainage
    - Stockpile for daily cover
- Excess Soil Stockpile

- Temporary Road to Excess Soil Stockpile for Excavation Equipment
- Off-Site Runoff Controls
    - Drainage diversion channel
    - Holding pond, sam, and spillway
- Treatment Facilities
    - Leachate lagoon and treatment plant
    - Outfall for treated leachate
- Settling pond for on-site runoff

Basic Work Elements: It is anticipated that the required construction would include the following basic elements:

- Earthwork: This work element would consist of the necessary excavation, earthmoving, stockpiling, compaction, rough grading, final grading and riprap operations related to site entrance road, permanent site road, temporary road to excess soil stockpile, temporary road to Stage 1 Landfill area, off-site runoff diversion channel, on-site runoff pond including outlet, dam and holding pond for off-site runoff, excavation of Stages 1 and 2 landfill areas (21 acres), daily cover stockpile, excess soil stockpile, earthfill north of waste disposal area, leachate lagoon, building areas, and other facility areas designated by the county.

- Site Improvements: This work element would include surfacing of roads, installation of utilities, construction of drainage channels and culverts outside of the waste disposal area, installation of buffer zone improvements, and installation of fencing and gates.

- Buildings and Facilities: This element would include construction of the gate house, employee and office building, vehicle storage shed, and scale foundation. Also included would be vehicle parking areas, vehicle wash facility and any other facilities or buildings designated by the county.

- Installation of Mechanical Equipment: This work element would include installing the liner and aerator for the leachate lagoon, leachate treatment plant, leachate pump station, truck scale, and any other equipment designated by the county.

- Waste Disposal Area Preparation: This work element would include installation of the leachate collecting pipeline network, installation of on-site surface runoff drainage pipeline network, construction of a leachate barrier on the bottom and sides of the excavated pit, and placement of the gas venting gravel layer along the eastern and western cut slopes. Only the Stage 1 landfill area (approximately 7 acres) would be prepared.

Phase II - Sanitary Landfill Operation

Approach

The waste disposal area will be filled with solid wastes and cover materials of on-site soils using sanitary landfill operating procedures to be developed by Snohomish County. The county will conduct the sanitary landfill operations.

The 56-acre waste disposal area should be prepared and filled to final elevations and grades in six stages, as indicated on Sheets 13 through 20 in Appendix C. Basically, each stage of operation consists of conducting a sanitary landfill operation in the first stage area, preparing the second stage area for receiving solid waste and excavating the third stage area to stockpile daily cover and other on-site soils for future sanitary landfill operations in the second stage area. This basic sequence of operations would be continued until the total 56-acre waste disposal area is filled to final elevations. The major portion of excavation and stockpiling operations should be accomplished during dry weather because the bulk of the on-site soils are moisture sensitive.

The total time of operation of the sanitary landfill is estimated to be approximately seven years based on waste generation forecasts by the county and on excavation depths and final contours shown in the drawings for each stage of operation. Estimates of excavation volumes, cover material requirements, waste capacity and time periods for completing each stage of landfill are summarized in Table 5.

Typical details and sections on Sheets 15 and 16 in Appendix C indicate the basic concepts recommended for each task. Details will be finalized after completion of surveys and other site investigations in Phase I.

Soils Classification

To facilitate this discussion, the soils to be utilized on the site have been classified into five groups according to their limitations and uses:

1) Soils Group A: Top of final cover.
   Uses: Top 0.5 to 1.0 feet of final cover.
   Purpose: Top soils as base for seeding.
   Soil Types: Forest duff (usually top 0.5 feet) and loose, very silty sands or silty fine to medium sands normally found in rooting zone (top 2 feet).
   Volume Required: Approximately 70,000 cubic yards total.
   Stockpile Placement: Uncompacted berms with 3 horizontal to 1 vertical side slopes.
   Weather Protection: Plant with grass as each segment of berm is completed to prevent erosion.

2) Soil Group B: Wet weather cover.
   Use: Daily cover for landfill during wet weather.
   Purpose: Source of dry, lower moisture-sensitive on-site soils.
   Soil Types: Weathered sandstone (silty fine to medium sands, silty sands) and excavated dense sandstone.
   Volume Required: Approximately 200,000 cubic yards total.
   Stockpile Placement: Excavate only during dry weather and place in berms with 3 horizontal to 1 vertical side slopes. Compact the top and side surfaces.
   Weather Protection: Cover with sheet plastic or other suitable material. Divert surface runoff away from berm.

Table 5

Summary of Quantities at End of Landfill Development Stage

Cathcart Sanitary Landfill

Item	Initial Site Construction	Stage of Sanitary Landfill Operation						
		I	II	III	IV	V	VI	Total
Solid Waste + Daily Cover (Cubic Yard)	0	319,000	759,000	566,000	443,000	385,000	437,000	2,909,000 C.Y.
Compacted Solid Waste								
Volume (C.Y.)[1]	0	254,000	604,000	450,000	352,000	307,000	348,000	2,315,000 C.Y.
Weight (Tons @ 1,000 (lb/C.Y.)	0	127,000	302,000	225,500	176,000	154,000	174,000	1,158,000 T.
Estimated Life (accum. Yrs)	--	1 yr.	3 yrs.	4.5 yrs.	5.5 yrs.	6.5 yrs.	7.3 yrs.	7.3 yrs.
Excavation								
Location	I & II areas	III area	IV area	V area	VI area	none	none	
Approx. Surface Area (Ac)	21	8.4	8.4	8.4	10.2	0	0	56.4 AC
Top Soil Material (C.Y.)[2]	17,000	6,800	6,800	6,800	8,300	0	0	45,700 C.Y.
Top Cover (C.Y.)[3]	51,000	20,200	20,200	20,200	24,700	0	0	136,300 C.Y.
Other Soils (C.Y.)	370,000	141,000	169,000	255,000	280,000	0	0	1,215,000 C.Y.
Total Cubic Yard	438,000	168,000	196,000	282,000	313,000	0	0	1,397,000 C.Y.
Required Cover								
Acres of Final Cover	0	0	15.5	8.9	8.4	9.3	14.3	56.4 AC
Top Soil @ 6" depth (C.Y.)	0	0	16,000	8,200	8,000	9,000	13,800	55,000 C.Y.
Top Cover @ 18" depth (C.Y.)	0	0	46,000	25,800	24,000	27,000	41,200	164,000 C.Y.
Daily Cover[1] (C.Y.)	0	65,000	156,000	116,000	90,000	78,000	89,000	594,000 C.Y.
Total Cubic Yard	0	65,000	218,000	150,000	122,000	114,000	144,000	813,000 C.Y.
Soil Stockpile At End of Stage								
Daily Cover (C.Y.)	65,000	156,000	116,000	90,000	78,000	89,000	0	
Top Soil (C.Y.)	17,000	23,800	14,600	13,200	13,500	4,500	(-9,300)	(-9,300 C.Y.)
Top Cover (C.Y.)	51,000	71,200	45,400	39,800	40,500	13,500	(-27,700)	(-27,700 C.Y.)
Other Soils (C.Y.)	305,000	290,000	343,000	508,000	710,000	621,000	621,000	621,000 .Y.
Total C. Y.	438,000	541,000	519,000	651,000	842,000	728,000	584,000	584,000 .Y.

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[1] Based on 3.9:1 waste to cover ratio for 10 ft. lift.
[2] Based on 6" top soil and 18" of top cover as average over site
[3] Based on 6" top soil and 18" top cover with factor of 1.2.

3) Soil Group C: Temporary site road.
Use: As surface and base material for the temporary site roads.
Purpose: Source of lowest moisture sensitive on-site soils.
Soil Type: Excavated dense sandstone (some blocks and clods are allowable) and any clean or relatively clean sands or gravels.
Volume Required: Approximately 30,000 cubic yards total.
Stockpile Placement: Excavate during any season and place in berms with 3 horizontal to 1 vertical side slopes. Compact the top and side surface areas.
Weather Protection: Cover with sheet plastic or other suitable material. Divert surface runoff away from berm.

4) Soil Group D: Final intermediate cover.
Use: One foot thick intermediate cover on top of final lift and exposed final side slopes of all lifts.
Purpose: Impervious barrier to keep water out of the landfill.
Soil Types: Excavated dense glacial till.
Volume Required: Approximately 110,000 cubic yards total.
Stockpile Placement: Excavate during dry weather and place in berm with 3 horizontal to 1 vertical side slopes. Compact the top and side surfaces.
Weather Protection: Cover with plastic sheeting or other suitable material.

5) Soil Group E: Dry weather cover.
Use: Daily cover for landfill during dry weather.
Purpose: Source of moderately dry on-site soils during dry weather operations.
Soil Type: Dense, glacial till and weathered glacial till (gravelly silty sands, silty gravelly sands).
Volume Required: Approximately 600,000 cubic yards total.
Stockpile Placement: Use directly from excavated materials or stockpile in uncompacted berms with 3 horizontal to 1 vertical side slopes. Top and side surfaces of berms should be compacted.
Weather Protection: Drain surface runoff away from berm.

The soil groups A through D will require that minimum volumes be stockpiled for future time periods of use. These volumes should receive first priority.

Very little of the clean sands and gravels for Soil Group C are expected to be available on-site and may be difficult to excavate without being contaminated. Imported soils or other on-site soils (i.e., excavated dense sandstone) may have to be used.

Imported gravels or other substitutes (wood chips, ashes, etc.) may have to be used for temporary road surfaces during wet weather conditions.

The predominant on-site soils are expected to be the dense glacial till, and weathered sandstone or till. Surplus volumes of dense till and weathered till are expected.

Stage 1 Landfill and Stage 2 Preparation

Tasks to be accomplished during the first stage of sanitary landfill operation, indicated on Sheet 13 in Appendix C, include:

- Sanitary Landfill in Stage 1 Area (approximately 11 acres):

  Fill with four lifts.
  Drain on-site runoff by moving inlet along 8-inch pipeline.
  Obtain daily cover from stockpile in Stage 2 and Stage 3 areas.

- Operate and Maintain Site Facilities:

  Off-site surface runoff diversion system.
  On-site surface runoff drainage system.
  Leachate collection and treatment system.
  Water quality monitoring system.
  Buildings, gate house and scale, roads, fencing, buffer strips, and other features in accordance with procedures developed by the county.

- Preparation of Stage 2 Area (Approximately 7 acres):

  Final grading after depletion of soil stockpile.
  Extend on-site drainage pipeline.
  Construct leachate barrier where required.
  Construct temporary site road.
  Place gravel for gas vent and leachate drain.

- Excavate Stage 3 Area (Approximately 8.4 Acres):

  Clear approximately 7.5 acres.
  Excavate approximately 168,000 cubic yards.
  Stockpile approximately 165,000 cubic yards of daily cover (Group B and E soils) in Stage 3 area.
  Stockpile remaining soils in excess soil stockpile area.

Stage 2 Landfill and Stage 3 Preparation

Tasks to be accomplished during the second stage of sanitary landfill operation, indicated on Sheet 14 in Appendix C, include:

- Sanitary Landfill in Stage 1 and Stage 2 Areas (Approximately 15.5 Acres):

  Fill Stage 2 area with four lifts.
  Continue filling both Stage 1 and Stage 2 areas to final elevations.
  Drain on-site runoff by moving inlet along 8-inch pipeline.

Obtain daily cover from Stage 3 and Stage 4 areas.
Complete gas venting system along east and west side of landfill.
Apply final cover, grade, and seed with grass.
Construct drainage channel for storm runoff from the completed landfill.
Install 8-inch clean-outs on end of on-site drainage pipeline and leachate pipeline.
Obtain soils for final cover from excess soil stockpile.

- Operate and Maintain Site Facilities:

  The same site facilities as in Stage 1 landfill would continue to be operated and maintained.

- Preparation of Stage 3 Area (Approximately 7 Acres):

  Final grading.
  Extend on-site drainage pipeline.
  Construct leachate barrier where required.
  Construct temporary site road.
  Place gravel for gas vent and leachate drain.

- Excavation of Stage 4 Area (Approximately 8.4 Acres):

  Clear approximately 7.5 acres.
  Excavate approximately 196,000 cubic yards.
  Stockpile approximately 123,000 cubic yards of daily cover (Group B and E soils) in Stage 4 area.
  Stockpile remaining soils in excess soil stockpile area.

Stage 3 Landfill and Stage 4 Preparation

Tasks to be accomplished during the third stage of sanitary landfill operation, indicated on Sheet 17 in Appendix C, include:

- Sanitary Landfill in Stage 3 Area (Approximately 8.9 Acres):

  Fill Stage 3 area with 5 to 6 lifts to final elevations.
  Drain on-site runoff by moving inlet along 8-inch pipeline.
  Obtain daily cover from Stage 4 and Stage 5 areas.
  Complete gas venting system along east and west side of landfill.
  Apply final cover, grade and seed with grass.
  Extend drainage channel along permanent site road for on-site runoff.
  Install clean-out on end of 8-inch on-site drainage pipeline.
  Obtain soils for final cover from excess soil stockpile.

- Operate and Maintain Site Facilities:

  The same site facilities as in Stage 1 landfill would continue to be operated and maintained.

- Preparation of Stage 4 Area (Approximately 7.3 Acres):

  Final grading.
  Extend on-site drainage pipeline.
  Construct leachate barrier where required.
  Construct temporary site road.
  Place gravel for gas vent and leachate drain.

- Relocate Excess Soil Stockpile Area:

  Prepare a permanent excess soil stockpile area (approximately 7 acres) outside of the waste disposal area. Work items will involve clearing, rough grading, drainage, and an access road across the off-site runoff diversion channel.

  Relocate soil stockpiles of special soil groups (Group A, B, C, and D) to the newly prepared area.

  Relocate, sell, or give away excess Group E soils not needed for future landfill operations. Approximate excess after completion of the fill area is estimated at 350,000 to 450,000 cubic yards. However, this volume is subject to monitoring of waste to daily cover ratios during initial stages of landfill operation. This material could be used to develop the future use contours or to extend the life of the waste disposal area.

- Excavation of Stage 5 Area (Approximately 8.4 Acres):

  Clear approximately 7.5 acres.
  Excavate approximately 282,000 cubic yards.
  Stockpile approximately 96,000 cubic yards of daily cover in Stage 5 area.
  Stockpile remaining soils in newly prepared excess soil stockpile area.

Stage 4 Landfill and Stage 5 Preparation

Tasks to be accomplished during the fourth stage of sanitary landfill operation, indicated on Sheet 18 in Appendix C, include:

- Sanitary Landfill in Stage 4 Area (Approximately 8.4 Acres):

  Fill Stage 4 area with 4 to 5 lifts to final elevation.
  Drain on-site runoff by moving inlet along 8-inch pipeline.
  Obtain daily cover from Stage 5 and Stage 6 areas.
  Complete gas venting system along east and west side of landfill.
  Apply final cover, grade and seed with grass.
  Extend drainage channel along permanent site road for on-site runoff.
  Install cleanout on end of 8-inch on-site drainage pipeline.
  Obtain soils for final cover from excess soil stockpile.

- Operate and Maintain Site Facilities:

  The same site facilities as in Stage 1 landfill would continue to be operated and maintained.

- Preparation of Stage 5 Area (Approximately 7.6 Acres):

  Final grading.
  Extend on-site drainage pipeline.
  Construct leachate barrier where required.
  Construct temporary site road.
  Place gravel for gas vent and leachate drain.

- Excavate Stage 6 Area (Approximately 10.2 Acres):

  Excavate approximately 313,000 cubic yards.
  Stockpile approximately 83,000 cubic yards of daily cover (Group B and E soils) in Stage 6 area.
  Stockpile remaining soils in excess soil stockpile area.

Stage 5 Landfill and Stage 6 Preparation

Tasks to be accomplished during the fifth stage of sanitary landfill operation, indicated on Sheet 19 in Appendix C, include:

- Sanitary Landfill in Stage 5 Area (Approximately 9.3 Acres):

  Fill Stage 5 area with 3 to 4 lifts to final elevation.
  Drain on-site runoff by moving inlet along 8-inch pipeline.
  Obtain daily cover from Stage 6 area.
  Complete gas venting system along east and west side of landfill.
  Apply final cover, grade and seed with grass.
  Extend drainage channel along permanent site road for on-site runoff.
  Install cleanout on end of 8-inch on-site drainage pipeline.
  Obtain soils for final cover from excess soil stockpile.

- Operate and Maintain Site Facilities:

  The same site facilities as in Stage 1 landfill would continue to be operated and maintained.

- Preparation of Stage 6 Area (Approximately 10.2 Acres):

  Final grading.
  Extend on-site drainage pipeline.
  Construct leachate barrier where required.
  Construct temporary site road.
  Place gravel for gas vent and leachate drain.

Stage 6 Landfill

Tasks to be accomplished during the sixth stage of sanitary landfill operation, indicated on Sheet 20 in Appendix C, include:

- Sanitary Landfill in Stage 6 Area (Approximately 14.3 Acres):

  Fill Stage 6 with 2 to 3 lifts to final elevations.
  Drain on-site runoff by moving the inlets along 8-inch pipeline.

Obtain daily cover from excess soil stockpile.
Complete gas venting system along east and west side of landfill.
Apply final cover, grade and seed with grass.
Extend drainage channel along permanent site road for on-site runoff.
Install clean-outs on end of 8-inch on-site drainage pipeline.
Obtain soil for final cover from excess soil stockpile.

- Operate and Mainatain Site Facilities:

  The same site facilities as in Stage 1 landfill would continue to be operated and maintained.

- Divert On-Site Drainage Pipeline to Leachate Collection System:

  After clean-outs are installed on the two 8-inch on-site drainage pipelines, the 18-inch pipeline north of the waste disposal area should be diverted into the leachate pump station.

Phase III - Final Use

Maintenance and Operation after Landfill Closure

Upon completion of the sanitary landfill operation, the waste disposal area should have been developed to the final elevations and grades shown on Sheet 21 in Appendix C. The following items should be operated and/or maintained for a minimum period of five years, unless otherwise noted.

Final Cover: Cracks, depressions or erosion marks that develop in the soil cover as the landfill settles should be filled with soil (Group A or D soils), graded and reseeded with grass. Approximately 50,000 cubic yards of soil should be retained in the excess soil storage area for maintenance.

On-Site Runoff Drainage Channel: The channel should be periodically inspected for adverse erosion which should be corrected by reconstructing the channel with Group A or D soils and reseeding with grass or by reconstructing the channel and lining it with rock, asphalt or other suitable materials.

Leachate Collection and Treatment System: The leachate collection pipeline and pump station should be maintained and the leachate treatment facility should continue to be operated until monitoring of the raw leachate quantity and quality indicates that the treatment facility can be eliminated. This may require many years of leachate treatment facility operation and maintenance. If leachate generation tapers off, it may be possible to store leachate in the lagoon for periodic batch treatment and discharge to the on-site runoff holding pond.

On-Site Runoff Holding Pond: Water quality should continue to be monitored prior to discharging pond water into the intermittent creek.

Off-Site Runoff Holding Pond and Drainage Channel: Both facilities should be maintained.

Gas Venting System: The vents should be maintained to prevent plugging and gases should be periodically monitored to determine the need for odor control.

Permanent Site Road: The road should be maintained for access to the leachate treatment facility.

Utilities: Utility service to the leachate treatment facility will be required.

Excess Soil Stockpile Area: Group A and D soils will periodically be required for maintenance of the final cover on the landfill. Other soils could be used for future site development.

Water Quality Monitoring: The routine water quality monitoring procedure should be continued by Snohomish County Department of Public Works until results indicate that monitoring is no longer required.

Final Use Development

Final use of the site is presently undefined. However, the final elevations and contours (refer to Sheet 21, Appendix C) have been selected to provide large gently sloped areas suitable for development of active recreation facilities (such as tennis courts, ball parks, soccer fields, archery range, golf course and bicycle pathways) and/or passive recreation facilities (such as parks, picnic areas, gardens, walkways or open space). As only 56 acres of the site would be filled with solid waste, considerable area will be suitable for structures. Large areas will be left in their natural condition. The holding ponds and the diverted creek could be developed to enhance the visual aesthetics of the site. The double lane service road will provide vehicle access to much of the site.

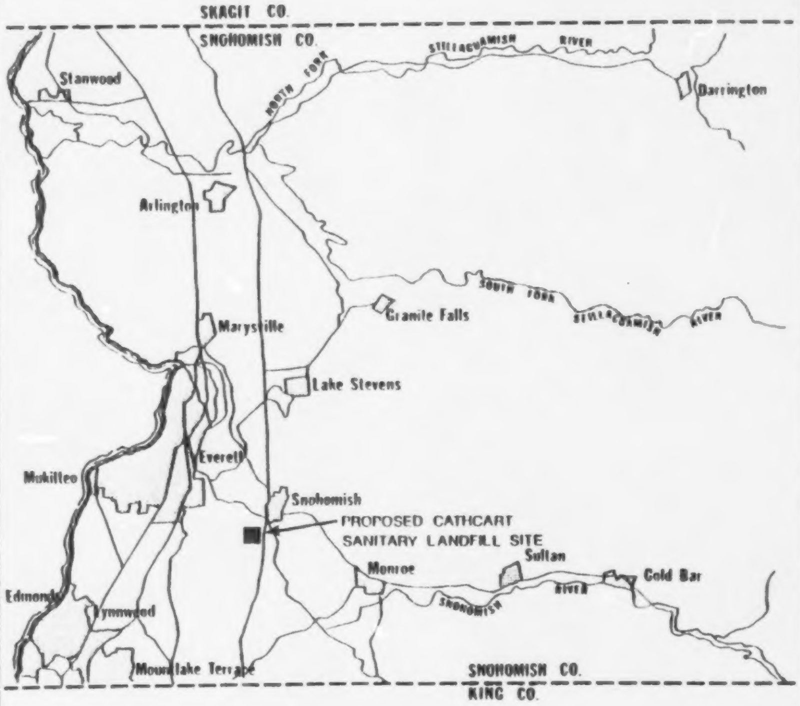
INDEX TO DRAWINGS

No.	Title
1	GENERAL SITE PLAN
2	PHASE I: Initial Site Preparation - Clearing and Site Investigations
3	PHASE I: Initial Site Construction Plan
4	PHASE I: Site Roads - Details
5	PHASE I: Stage 1 and 2 Excavation Sections
6	PHASE I: Stage 1 Leachate Collection and On-Site Runoff Drainage Plan
7	PHASE I: Leachate and Drainage Pipelines at North End of Stage 1
8	PHASE I: Leachate Collection System Details
9	PHASE I: On-Site Runoff Drainage System Details
10	PHASE I: Leachate Treatment Facility
11	PHASE I: Off-Site Runoff Holding Pond
12	PHASE I: Off-Site Runoff Diversion Channel
13	PHASE II: Stage 1 Landfill and Stage 2 Preparation Plan
14	PHASE II: Stage 1 and 2 Landfill and Stage 3 Preparation Plan
15	PHASE II: Stage 1 and 2 Landfill and Stage 3 Detail
16	PHASE II: Daily Cover, Final Cover and Gas Control Details
17	PHASE II: Stage 3 Landfill and Stage 4 Preparation Plan
18	PHASE II: Stage 4 Landfill and Stage 5 Preparation Plan
19	PHASE II: Stage 5 Landfill and Stage 6 Preparation Plan
20	PHASE II: Stage 6 Landfill
21	PHASE III: Base Site For Future Use

SNOHOMISH COUNTY

CATHCART SANITARY LANDFILL

JANUARY 1975


SKAGIT CO.
SNOHOMISH CO.
STILLAGUAMISH RIVER
NORTH FORK
Stanwood
Darrington
Arlington
SOUTH FORK STILLAGUAMISH RIVER
Marysville
Granite Falls
Lake Stevens
Everett
Mukilteo
Snohomish
PROPOSED CATHCART SANITARY LANDFILL SITE
Sultan
Monroe
Gold Bar
SNOHOMISH RIVER
Edmonds
Lynnwood
Mountlake Terrace
SNOHOMISH CO.
KING CO.

Stevens, Thompson & Runyan, Inc.
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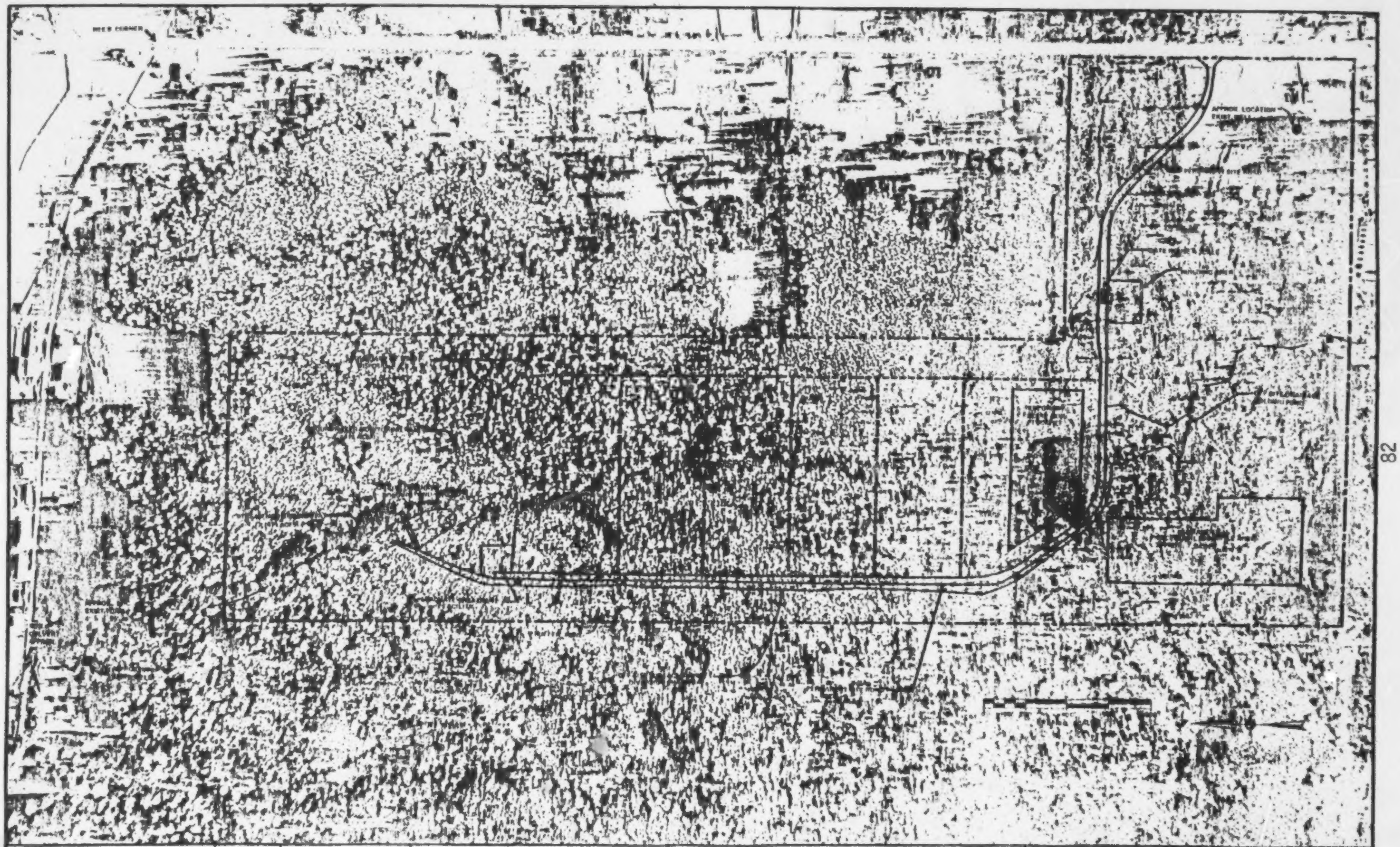

R.T.T.
G.E.C.
RHH

AS SHOWN JULY 75
73-S-466.032

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SNOHOMISH COUNTY
CATHCART SANITARY LANDFILL

GENERAL LAYOUT PLAN

1/21

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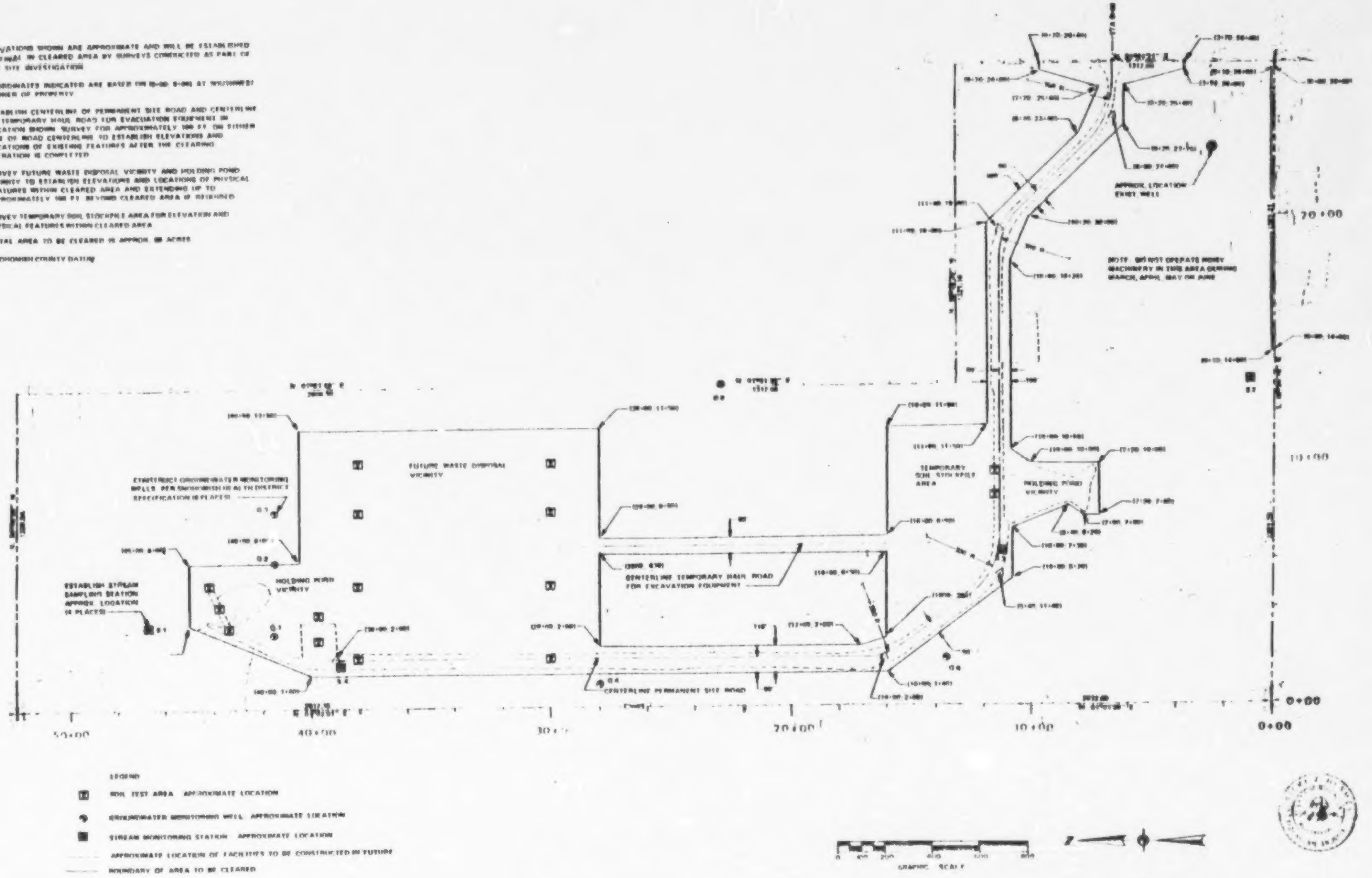
NOTES

1. ELEVATIONS SHOWN ARE APPROXIMATE AND WILL BE ESTABLISHED AS FINAL IN CLEARED AREA BY SURVEYS CONDUCTED AS PART OF THE SITE INVESTIGATION
2. COORDINATES INDICATED ARE BASED ON [illegible] AT SOUTHWEST CORNER OF PROPERTY
3. ESTABLISH CENTERLINE OF PERMANENT SITE ROAD AND CENTERLINE OF TEMPORARY HAUL ROAD FOR EVACUATION EQUIPMENT IN LOCATION SHOWN. SURVEY FOR APPROXIMATELY 100 FT ON EITHER SIDE OF ROAD CENTERLINE TO ESTABLISH ELEVATIONS AND LOCATIONS OF EXISTING FEATURES AFTER THE CLEARING OPERATION IS COMPLETED
4. SURVEY FUTURE WASTE DISPOSAL VICINITY AND HOLDING POND VICINITY TO ESTABLISH ELEVATIONS AND LOCATIONS OF PHYSICAL FEATURES WITHIN CLEARED AREA AND EXTENDING UP TO APPROXIMATELY 100 FT BEYOND CLEARED AREA IF REQUIRED
5. SURVEY TEMPORARY SOIL STOCKPILE AREA FOR ELEVATION AND PHYSICAL FEATURES WITHIN CLEARED AREA
6. TOTAL AREA TO BE CLEARED IS APPROX. [illegible] ACRES
7. SNOHOMISH COUNTY DATUM

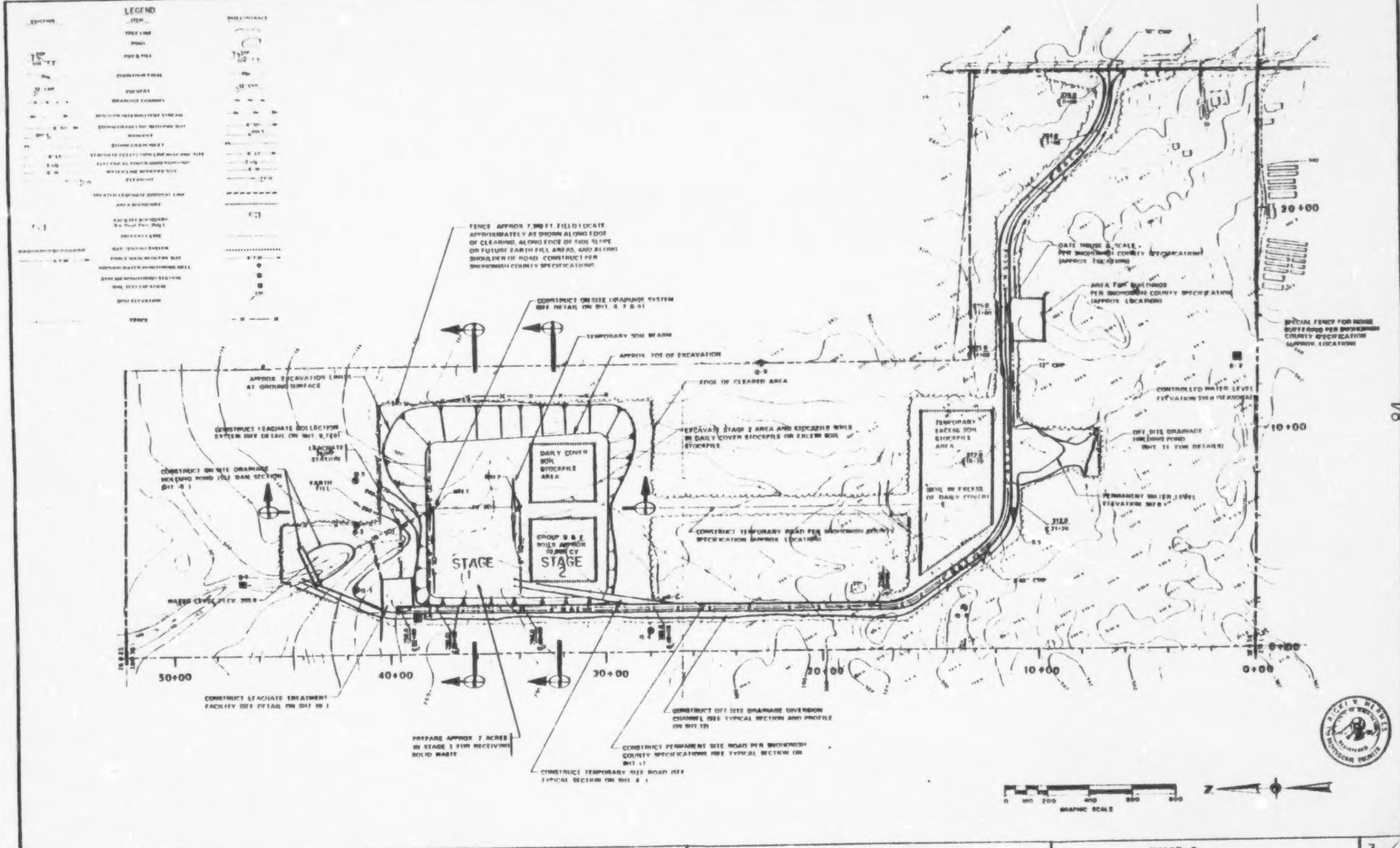

NOTE: DO NOT OPERATE HEAVY MACHINERY IN THIS AREA DURING MARCH, APRIL, MAY OR JUNE
APPROX. LOCATION EXIST. WELL
TEMPORARY SOIL STOCKPILE AREA
HOLDING POND VICINITY
FUTURE WASTE DISPOSAL VICINITY
CONSTRUCT GROUNDWATER MONITORING WELLS PER SNOHOMISH HEALTH DISTRICT SPECIFICATION (6 PLACES)
ESTABLISH STREAM SAMPLING STATION APPROX. LOCATION (4 PLACES)
CENTERLINE TEMPORARY HAUL ROAD FOR EXCAVATION EQUIPMENT
CENTERLINE PERMANENT SITE ROAD
0+00
10+00
20+00
30+00
40+00
50+00
0
100
200
400
600
800
GRAPHIC SCALE

LEGEND

- ▣ SOIL TEST AREA APPROXIMATE LOCATION
- ● GROUNDWATER MONITORING WELL APPROXIMATE LOCATION
- ■ STREAM MONITORING STATION APPROXIMATE LOCATION
- APPROXIMATE LOCATION OF FACILITIES TO BE CONSTRUCTED IN FUTURE
- BOUNDARY OF AREA TO BE CLEARED

DATE	NO.	REVISION	BY	
DESIGNED R.T.T DRAWN G.E.C CHECKED R.V.H.	APPROVED SCALE AS SHOWN DATE JULY 75 FILE 73-S-486 032	Stevens, Thompson & Runyan, Inc. Engineers/Planners	SNOHOMISH COUNTY CATHCART SANITARY LANDFILL	PHASE I INITIAL SITE PREPARATION CLEARING AND SITE INVESTIGATION

2/21


LEGEND
FENCE APPROX 7,300 FT FIELD LOCATE APPROXIMATELY AS SHOWN ALONG EDGE OF CLEARING, ALONG EDGE OF SIDE SLOPE OR FUTURE EARTH FILL AREAS, AND ALONG SHOULDER OF ROAD CONSTRUCT PER SNOHOMISH COUNTY SPECIFICATIONS
CONSTRUCT ON SITE DRAINAGE SYSTEM SEE DETAIL ON SHT. 6, 7 & 9
TEMPORARY SOIL BERM
APPROX. TOE OF EXCAVATION
APPROX. EXCAVATION LIMITS AT GROUND SURFACE
EDGE OF CLEARED AREA
CONSTRUCT LEACHATE COLLECTION SYSTEM SEE DETAIL ON SHT. 9
LEACHATE STATION
CONSTRUCT ON SITE DRAINAGE HOLDING POND (SEE DAM SECTION SHT. 8)
EARTH FILL
DAILY COVER SOIL STOCKPILE AREA
GROUP B & C SOILS APPROX CY
STAGE 2
STAGE 1
EXCAVATE STAGE 2 AREA AND STOCKPILE SOILS IN DAILY COVER STOCKPILE OR EXCESS SOIL STOCKPILE
CONSTRUCT TEMPORARY ROAD PER SNOHOMISH COUNTY SPECIFICATION APPROX. LOCATION
TEMPORARY EXCESS SOIL STOCKPILE AREA
SOIL IN EXCESS OF DAILY COVER
WATER LEVEL ELEV.
50+00
40+00
30+00
20+00
10+00
0+00
CONSTRUCT LEACHATE TREATMENT FACILITY SEE DETAIL ON SHT 10
PREPARE APPROX. 7 ACRES IN STAGE 1 FOR RECEIVING SOLID WASTE
CONSTRUCT TEMPORARY SITE ROAD (SEE TYPICAL SECTION ON SHT. 4)
CONSTRUCT PERMANENT SITE ROAD PER SNOHOMISH COUNTY SPECIFICATIONS SEE TYPICAL SECTION ON SHT. 4
CONSTRUCT OFF SITE DRAINAGE DIVERSION CHANNEL SEE TYPICAL SECTION AND PROFILE ON SHT 12
GATE HOUSE & SCALE PER SNOHOMISH COUNTY SPECIFICATIONS (APPROX. LOCATION)
AREA FOR BUILDINGS PER SNOHOMISH COUNTY SPECIFICATION (APPROX. LOCATION)
SPECIAL FENCE FOR NOISE BUFFERING PER SNOHOMISH COUNTY SPECIFICATION (APPROX. LOCATION)
12" CMP
CONTROLLED WATER LEVEL ELEVATION
OFF SITE DRAINAGE HOLDING POND (SHT. 11 FOR DETAILS)
PERMANENT WATER LEVEL ELEVATION
20+00
10+00
0+00
N
0 100 200 400 600 800
GRAPHIC SCALE

DESIGNED R.T.Y.	APPROVED	**Stevens, Thompson & Runyan, Inc.** Engineers / Planners PORTLAND SEATTLE BOISE SPOKANE HOUSTON	SNOHOMISH COUNTY CATHCART SANITARY LANDFILL
DRAWN B.E.C.	SCALE AS SHOWN DATE JULY 75		PHASE I INITIAL SITE CONSTRUCTION PLAN
CHECKED R.V.H.	FILE 73-S-486.032		3/21

DATE NO REVISION BY

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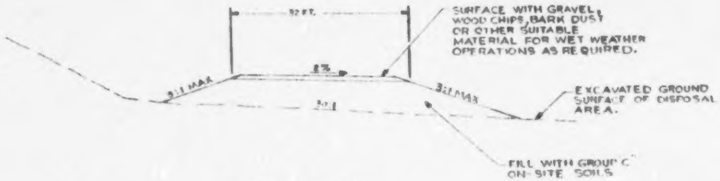
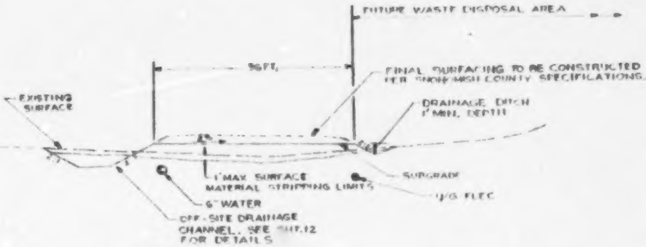
84

85.


32 FT.
SURFACE WITH GRAVEL, WOOD CHIPS, BARK DUST OR OTHER SUITABLE MATERIAL FOR WET WEATHER OPERATIONS AS REQUIRED.
2%
3:1 MAX
3:1 MAX
3:1
EXCAVATED GROUND SURFACE OF DISPOSAL AREA.
FILL WITH GROUP C ON-SITE SOILS

TEMPORARY SITE ROAD
(SCALE: 1"=10')

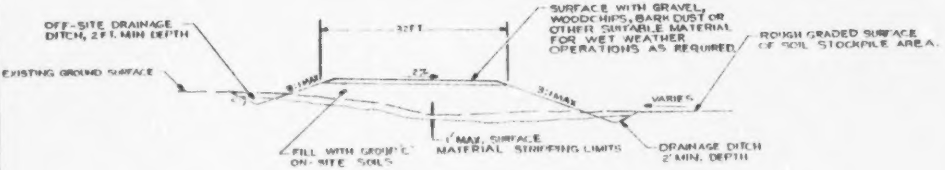

FUTURE WASTE DISPOSAL AREA
96 FT.
EXISTING SURFACE
FINAL SURFACING TO BE CONSTRUCTED PER SNOHOMISH COUNTY SPECIFICATIONS.
DRAINAGE DITCH 1' MIN. DEPTH
2%
1' MAX SURFACE MATERIAL STRIPPING LIMITS
SUBGRADE
U/G ELEC
6" WATER
OFF-SITE DRAINAGE CHANNEL, SEE SHT.12 FOR DETAILS

PERMANENT SITE ROAD
GENERAL SECTION
(NO SCALE)

NOTES:

1. TEMPORARY SITE ROAD WILL BE RELOCATED PERIODICALLY DURING DIFFERENT STAGES OF LANDFILL DEVELOPMENT. ROAD FILL MATERIALS SHOULD BE REMOVED TO ALLOW SPACE FOR SOLID WASTE.

85


OFF-SITE DRAINAGE DITCH, 2 FT. MIN DEPTH
EXISTING GROUND SURFACE
32 FT.
SURFACE WITH GRAVEL, WOODCHIPS, BARK DUST OR OTHER SUITABLE MATERIAL FOR WET WEATHER OPERATIONS AS REQUIRED.
ROUGH GRADED SURFACE OF SOIL STOCKPILE AREA.
3:1 MAX
2%
3:1 MAX
VARIES
FILL WITH GROUP C ON-SITE SOILS
1' MAX. SURFACE MATERIAL STRIPPING LIMITS
DRAINAGE DITCH 2' MIN. DEPTH

SOIL STOCKPILE AREA ACCESS ROAD
(SCALE: 1"=10')

R.T.T.
G.E.C.
RVH
AS NOTED
JULY 75
73-S-496.032

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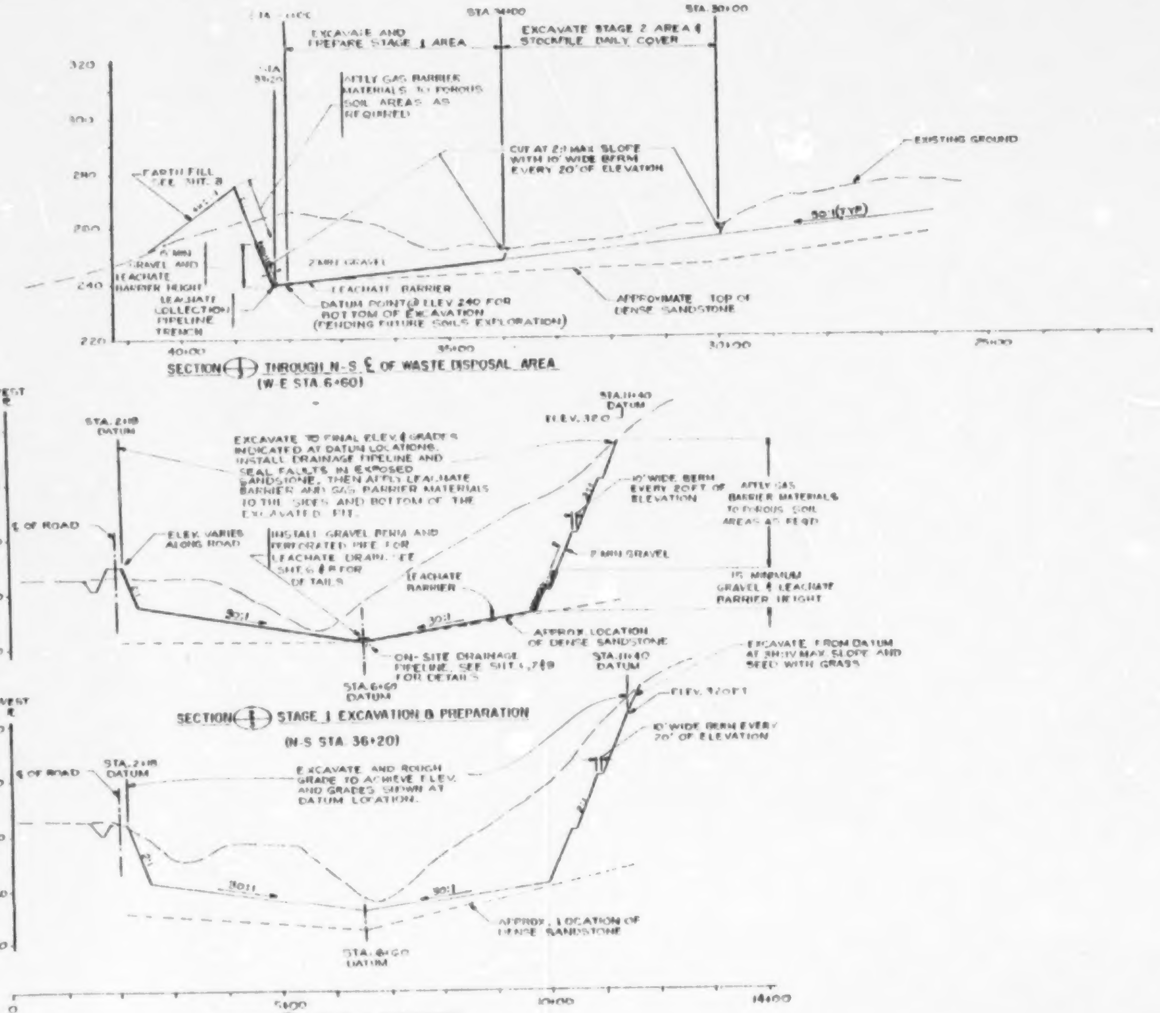
SNOHOMISH COUNTY
CATHCART SANITARY LANDFILL

SITE ROAD DETAILS

4
21


STA 34+00
STA 30+00
EXCAVATE AND PREPARE STAGE 1 AREA
EXCAVATE STAGE 2 AREA & STOCKPILE DAILY COVER
STA 33+20
APPLY GAS BARRIER MATERIALS TO POROUS SOIL AREAS AS REQUIRED
CUT AT 2:1 MAX SLOPE WITH 10' WIDE BERM EVERY 20' OF ELEVATION
EXISTING GROUND
EARTH FILL SEE SHT. 8
50:1 (TYP)
15' MIN GRAVEL AND LEACHATE BARRIER HEIGHT
2' MIN GRAVEL
LEACHATE COLLECTION PIPELINE TRENCH
LEACHATE BARRIER
DATUM POINT @ ELEV 240 FOR BOTTOM OF EXCAVATION (PENDING FUTURE SOILS EXPLORATION)
APPROXIMATE TOP OF DENSE SANDSTONE
320
300
280
260
240
220
40+00
35+00
30+00
25+00

SECTION THROUGH N-S ℄ OF WASTE DISPOSAL AREA
(W-E STA 6+60)

WEST ℄
STA. 2+18 DATUM
℄ OF ROAD
ELEV. VARIES ALONG ROAD
EXCAVATE TO FINAL ELEV. & GRADES INDICATED AT DATUM LOCATIONS. INSTALL DRAINAGE PIPELINE AND SEAL FAULTS IN EXPOSED SANDSTONE, THEN APPLY LEACHATE BARRIER AND GAS BARRIER MATERIALS TO THE SIDES AND BOTTOM OF THE EXCAVATED PIT.
INSTALL GRAVEL BERM AND PERFORATED PIPE FOR LEACHATE DRAIN. SEE SHT. 6 & 8 FOR DETAILS
LEACHATE BARRIER
30:1
STA. 11+40 DATUM
ELEV. 320
10' WIDE BERM EVERY 20 FT OF ELEVATION
APPLY GAS BARRIER MATERIALS TO POROUS SOIL AREAS AS REQD
2' MIN GRAVEL
15' MINIMUM GRAVEL & LEACHATE BARRIER HEIGHT
APPROX. LOCATION OF DENSE SANDSTONE
ON-SITE DRAINAGE PIPELINE. SEE SHT. 6, 7 & 8 FOR DETAILS
STA. 6+60 DATUM
320
300
280
260
240

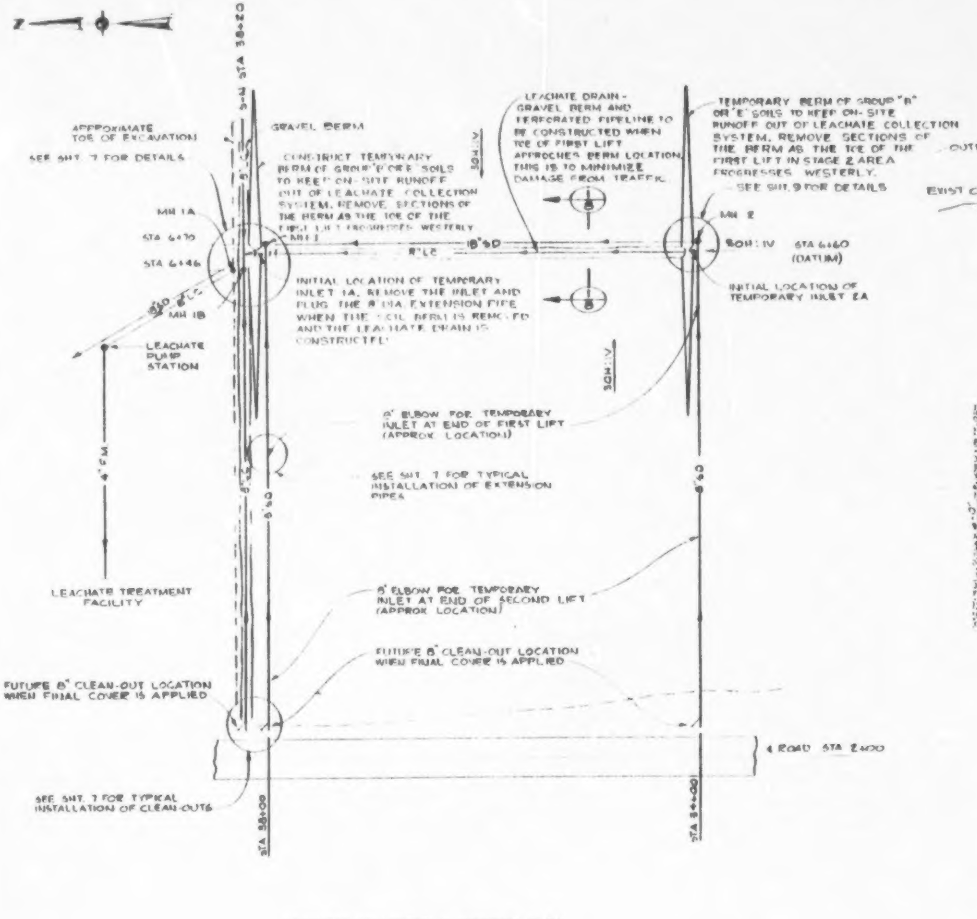
SECTION STAGE 1 EXCAVATION & PREPARATION
(N-S STA. 36+20)

WEST ℄
℄ OF ROAD
STA. 2+18 DATUM
EXCAVATE AND ROUGH GRADE TO ACHIEVE ELEV. AND GRADES SHOWN AT DATUM LOCATION.
STA. 11+40 DATUM
EXCAVATE FROM DATUM AT 3H:1V MAX SLOPE AND SEED WITH GRASS
ELEV. 320 ± 1
10' WIDE BERM EVERY 20' OF ELEVATION
2:1
30:1
APPROX. LOCATION OF DENSE SANDSTONE
STA. 6+60 DATUM
320
300
280
260
240
0
5+00
10+00
14+00

SECTION STAGE 2 EXCAVATION
(N-S STA 32+20)

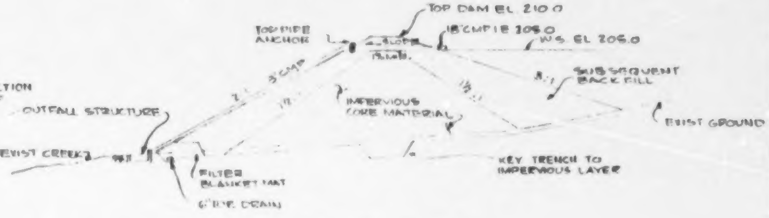
DESIGNED R.T.T.	APPROVED	Stevens, Thompson & Runyan, Inc. Engineers / Planners	SNOHOMISH COUNTY CATHCART SANITARY LANDFILL	STAGE 1 & 2 EXCAVATION SECTIONS	5/21
DRAWN G.E.C.	SCALE AS SHOWN DATE JULY 79				
CHECKED RVH	FILE 73-8-466.032				

DATE NO. REVISION BY


N
S-N STA 38+20
APPROXIMATE TOE OF EXCAVATION
SEE SHT. 7 FOR DETAILS
GRAVEL BERM
CONSTRUCT TEMPORARY BERM OF GROUP "B" OR "E" SOILS TO KEEP ON-SITE RUNOFF OUT OF LEACHATE COLLECTION SYSTEM. REMOVE SECTIONS OF THE BERM AS THE TOE OF THE FIRST LIFT PROGRESSES WESTERLY.
MH 1A
STA 6+70
STA 6+46
MH 1
8"LC
18"SD
MH 1B
LEACHATE PUMP STATION
4"FM
LEACHATE TREATMENT FACILITY
INITIAL LOCATION OF TEMPORARY INLET 1A. REMOVE THE INLET AND PLUG THE 8" DIA. EXTENSION PIPE WHEN THE SOIL BERM IS REMOVED AND THE LEACHATE DRAIN IS CONSTRUCTED.
LEACHATE DRAIN - GRAVEL BERM AND PERFORATED PIPELINE TO BE CONSTRUCTED WHEN TOE OF FIRST LIFT APPROCHES BERM LOCATION. THIS IS TO MINIMIZE DAMAGE FROM TRAFFIC.
30H:1V
B
TEMPORARY BERM OF GROUP "B" OR "E" SOILS TO KEEP ON-SITE RUNOFF OUT OF LEACHATE COLLECTION SYSTEM. REMOVE SECTIONS OF THE BERM AS THE TOE OF THE FIRST LIFT IN STAGE 2 AREA PROGRESSES WESTERLY.
SEE SHT. 9 FOR DETAILS
MH 2
30H:1V
STA 6+60 (DATUM)
INITIAL LOCATION OF TEMPORARY INLET 2A
8" ELBOW FOR TEMPORARY INLET AT END OF FIRST LIFT (APPROX. LOCATION)
SEE SHT. 7 FOR TYPICAL INSTALLATION OF EXTENSION PIPES
8"LC
8"SD
8" ELBOW FOR TEMPORARY INLET AT END OF SECOND LIFT (APPROX. LOCATION)
FUTURE 8" CLEAN-OUT LOCATION WHEN FINAL COVER IS APPLIED
FUTURE 8" CLEAN-OUT LOCATION WHEN FINAL COVER IS APPLIED
℄ ROAD STA 2+00
SEE SHT. 7 FOR TYPICAL INSTALLATION OF CLEAN-OUTS
STA 38+00
STA 34+00

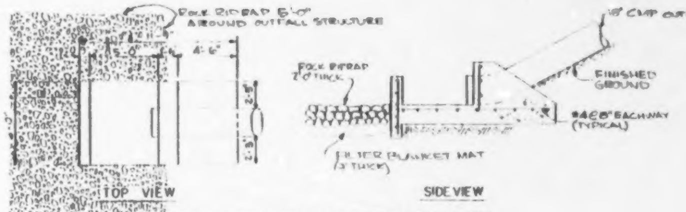
LEACHATE COLLECTION & DRAINAGE PLAN

SCALE 1"=50'


TOP PIPE ANCHOR
TOP DAM EL 210.0
18"CMP IE 208.0
W.S. EL 205.0
3:1
SUBSEQUENT BACK FILL
EXIST GROUND
OUTFALL STRUCTURE
18" CMP
IMPERVIOUS CORE MATERIAL
EXIST CREEK
FILTER BLANKET MAT
6" PIPE DRAIN
KEY TRENCH TO IMPERVIOUS LAYER

ON SITE SURFACE RUNOFF DAM SECTION

SCALE 1"=20'

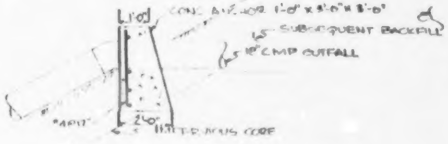

ROCK RIPRAP 6'-0" AROUND OUTFALL STRUCTURE
4'-6"
2'-8"
ROCK RIPRAP 2'-0" THICK
18" CMP OUTFALL
FINISHED GROUND
#4 @ 6" EACH WAY (TYPICAL)
FILTER BLANKET MAT (1' THICK)

TOP VIEW

SIDE VIEW

BOTTOM PIPE ANCHOR AND OUTFALL STRUCTURE

SCALE NONE


1'-0"
CONC. ANCHOR 1'-0" x 3'-0" x 3'-0"
SUBSEQUENT BACKFILL
18" CMP OUTFALL
2'-0"
IMPERVIOUS CORE

TOP PIPE ANCHOR

SCALE NONE

DESIGNED RTT
DRAWN HAC
CHECKED RVH
APPROVED [illegible]
SCALE AS NOTED
DATE JULY 75
JOB 73-S-4860.32

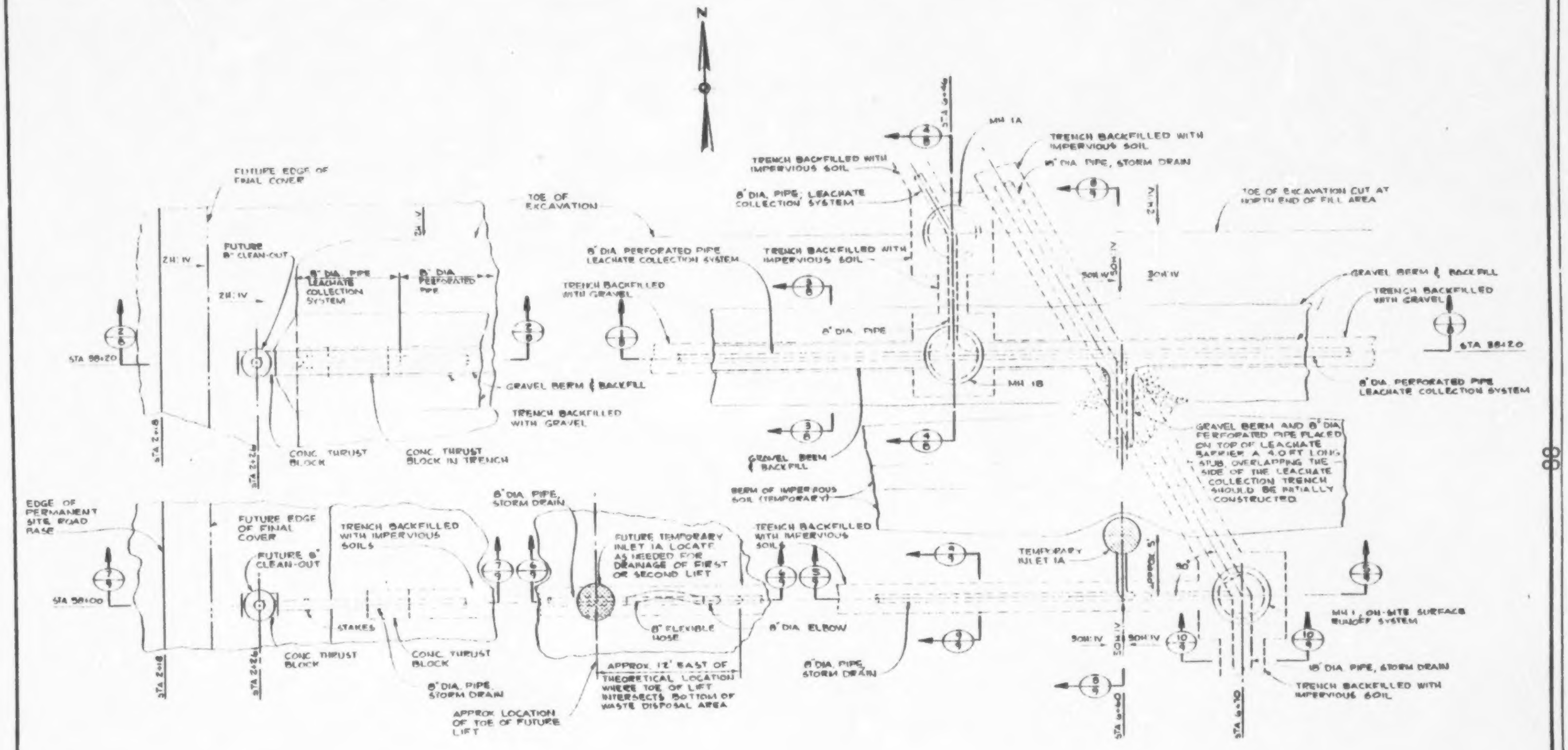
Stevens, Thompson & Runyan, Inc.
Engineers/Planners
PORTLAND SEATTLE BOISE SPOKANE [illegible]

SNOHOMISH COUNTY
CATHCART SANITARY LANDFILL

STAGE I LEACHATE COLLECTION AND
ON-SITE RUNOFF DRAINAGE PLAN

6/21

87


N
FUTURE EDGE OF FINAL COVER
FUTURE 8" CLEAN-OUT
2H:1V
8" DIA. PIPE LEACHATE COLLECTION SYSTEM
8" DIA PERFORATED PIPE
STA 58+20
STA 2+8
STA 2+26
CONC. THRUST BLOCK
CONC. THRUST BLOCK IN TRENCH
GRAVEL BERM & BACKFILL
TRENCH BACKFILLED WITH GRAVEL
TOE OF EXCAVATION
8" DIA PERFORATED PIPE LEACHATE COLLECTION SYSTEM
TRENCH BACKFILLED WITH GRAVEL
TRENCH BACKFILLED WITH IMPERVIOUS SOIL
8" DIA. PIPE, LEACHATE COLLECTION SYSTEM
TRENCH BACKFILLED WITH IMPERVIOUS SOIL
8" DIA. PIPE
GRAVEL BERM BACKFILL
BERM OF IMPERVIOUS SOIL (TEMPORARY)
STA 6+00
MH 1A
MH 1B
TRENCH BACKFILLED WITH IMPERVIOUS SOIL
8" DIA. PIPE, STORM DRAIN
TOE OF EXCAVATION CUT AT NORTH END OF FILL AREA
30H:1V
GRAVEL BERM & BACKFILL
TRENCH BACKFILLED WITH GRAVEL
STA 58+20
8" DIA PERFORATED PIPE LEACHATE COLLECTION SYSTEM
GRAVEL BERM AND 8" DIA PERFORATED PIPE PLACED ON TOP OF LEACHATE BARRIER A 4.0 FT LONG STUB OVERLAPPING THE SIDE OF THE LEACHATE COLLECTION TRENCH SHOULD BE PARTIALLY CONSTRUCTED
EDGE OF PERMANENT SITE ROAD BASE
STA 58+00
FUTURE EDGE OF FINAL COVER
FUTURE 8" CLEAN-OUT
TRENCH BACKFILLED WITH IMPERVIOUS SOILS
STAKES
CONC. THRUST BLOCK
CONC. THRUST BLOCK
8" DIA. PIPE, STORM DRAIN
APPROX LOCATION OF TOE OF FUTURE LIFT
8" DIA. PIPE, STORM DRAIN
FUTURE TEMPORARY INLET 1A LOCATE AS NEEDED FOR DRAINAGE OF FIRST OR SECOND LIFT
8" FLEXIBLE HOSE
APPROX. 12' EAST OF THEORETICAL LOCATION WHERE TOE OF LIFT INTERSECTS BOTTOM OF WASTE DISPOSAL AREA
TRENCH BACKFILLED WITH IMPERVIOUS SOIL
8" DIA ELBOW
8" DIA. PIPE, STORM DRAIN
TEMPORARY INLET 1A
5' ROAD
90°
30H:1V
STA 6+00
STA 6+10
MH 1, ON-SITE SURFACE RUNOFF SYSTEM
15" DIA PIPE, STORM DRAIN
TRENCH BACKFILLED WITH IMPERVIOUS SOIL

LEACHATE & DRAINAGE PIPELINES
AT NORTH END OF STAGE I
PLAN VIEW
SCALE: 1"=4'

DATE | NO. | REVISION | BY

DESIGNED RTT
DRAWN HAC
CHECKED RVH

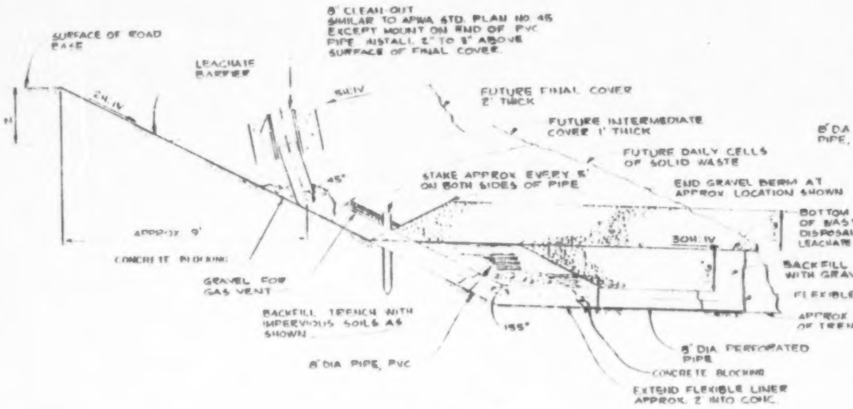
APPROVED
SCALE AS NOTED DATE JULY 75
JOB 73-S-486.032

Stevens, Thompson & Runyan, Inc.
Engineers / Planners

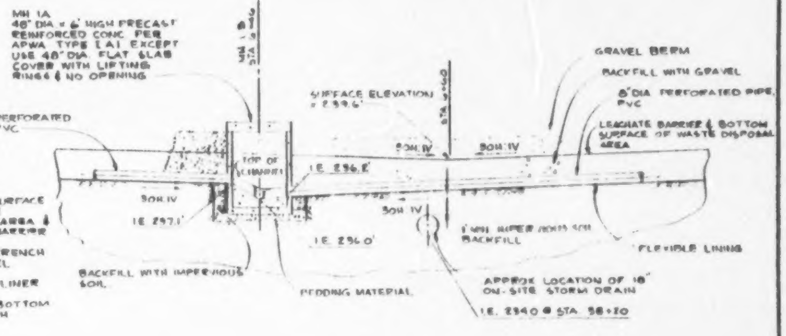
SNOHOMISH COUNTY
CATHCART SANITARY LANDFILL

LEACHATE AND DRAINAGE PIPELINES
AT NORTH END OF STAGE I

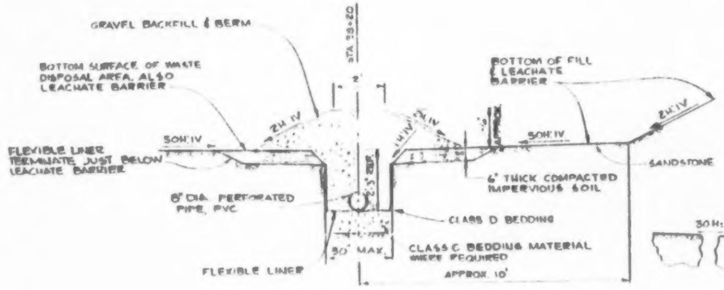
7
21


SURFACE OF ROAD BASE
LEACHATE BARRIER
8" CLEAN-OUT SIMILAR TO APWA STD. PLAN NO 45 EXCEPT MOUNT ON END OF PVC PIPE. INSTALL 2" TO 3" ABOVE SURFACE OF FINAL COVER.
2H:1V
5H:1V
FUTURE FINAL COVER 2' THICK
FUTURE INTERMEDIATE COVER 1' THICK
FUTURE DAILY CELLS OF SOLID WASTE
45°
STAKE APPROX EVERY 5' ON BOTH SIDES OF PIPE
END GRAVEL BERM AT APPROX LOCATION SHOWN
BOTTOM SURFACE OF WASTE DISPOSAL AREA & LEACHATE BARRIER
30H:1V
APPROX 9'
CONCRETE BLOCKING
GRAVEL FOR GAS VENT
BACKFILL TRENCH WITH IMPERVIOUS SOILS AS SHOWN
8" DIA PIPE, PVC
135°
BACKFILL TRENCH WITH GRAVEL
FLEXIBLE LINER
APPROX BOTTOM OF TRENCH
8" DIA PERFORATED PIPE
CONCRETE BLOCKING
EXTEND FLEXIBLE LINER APPROX. 2' INTO CONC.

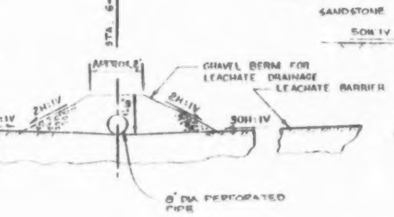
SECTION 2/7
SCALE 1"=2'


MH 1A
48" DIA × 6' HIGH PRECAST REINFORCED CONC. PER APWA TYPE I A1 EXCEPT USE 48" DIA. FLAT SLAB COVER WITH LIFTING RINGS & NO OPENING
STA
8" DIA PERFORATED PIPE, PVC
SURFACE ELEVATION = 239.6'
STA
GRAVEL BERM
BACKFILL WITH GRAVEL
8" DIA PERFORATED PIPE, PVC
LEACHATE BARRIER & BOTTOM SURFACE OF WASTE DISPOSAL AREA
TOP OF CHANNEL
I.E. 236.8'
30H:1V
30H:1V
30H:1V
30H:1V
I.E. 237.1'
I.E. 236.0'
1 MIN. IMPERVIOUS SOIL BACKFILL
FLEXIBLE LINING
BACKFILL WITH IMPERVIOUS SOIL
BEDDING MATERIAL
APPROX LOCATION OF 18" ON-SITE STORM DRAIN
I.E. 234.0 @ STA. 38+20

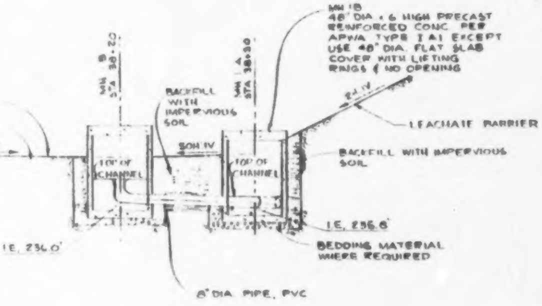
SECTION 1/7
SCALE 1"=4'


GRAVEL BACKFILL & BERM
STA 38+20
BOTTOM SURFACE OF WASTE DISPOSAL AREA, ALSO LEACHATE BARRIER
2'
2H:1V
2H:1V
1H:1V
BOTTOM OF FILL & LEACHATE BARRIER
2H:1V
30H:1V
30H:1V
FLEXIBLE LINER TERMINATE JUST BELOW LEACHATE BARRIER
SANDSTONE
6" THICK COMPACTED IMPERVIOUS SOIL
8" DIA. PERFORATED PIPE, PVC
2.5'
CLASS D BEDDING
30" MAX.
CLASS C BEDDING MATERIAL WHERE REQUIRED
FLEXIBLE LINER
APPROX. 10'

SECTION 3/7
SCALE 1"=2'

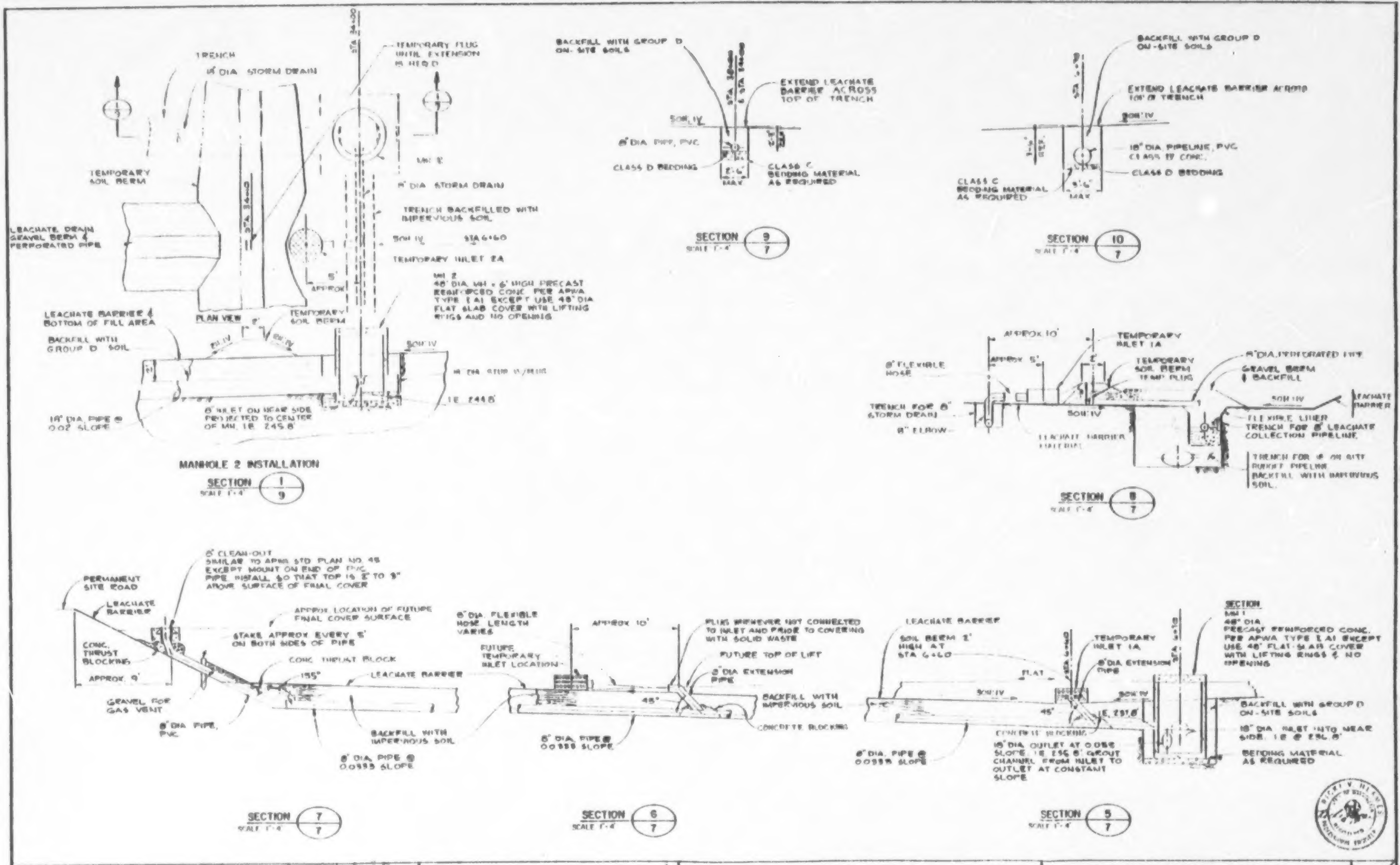

STA. 6+80
APPROX 2'
GRAVEL BERM FOR LEACHATE DRAINAGE
LEACHATE BARRIER
2H:1V
2H:1V
30H:1V
30H:1V
8" DIA PERFORATED PIPE

SECTION 1/6
SCALE 1"=2'

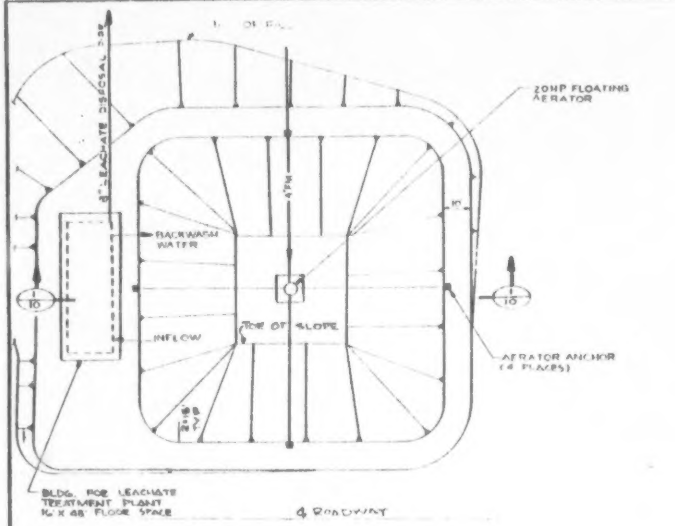

MH 1B
48" DIA × 6 HIGH PRECAST REINFORCED CONC. PER APWA TYPE I A1 EXCEPT USE 48" DIA. FLAT SLAB COVER WITH LIFTING RINGS & NO OPENING
MH 1B STA. 38+20
MH 1A STA. 38+30
BOTTOM OF FILL & LEACHATE BARRIER
SANDSTONE
30H:1V
30H:1V
BACKFILL WITH IMPERVIOUS SOIL
2H:1V
LEACHATE BARRIER
TOP OF CHANNEL
TOP OF CHANNEL
BACKFILL WITH IMPERVIOUS SOIL
I.E. 236.0'
I.E. 236.8'
BEDDING MATERIAL WHERE REQUIRED
8" DIA PIPE, PVC

SECTION 4/7
SCALE 1"=4'

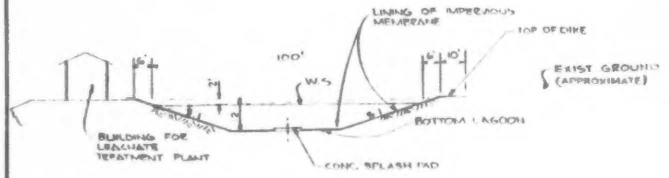
RTT HAC RVH	SM/ZG/ZF AS NOTED 75 S 486032	Stevens, Thompson & Runyan, Inc. Engineers / Planners	SNOHOMISH COUNTY CATHCART SANITARY LANDFILL	LEACHATE COLLECTION SYSTEM DETAILS	8/21


TRENCH
18" DIA STORM DRAIN
TEMPORARY SOIL BERM
LEACHATE DRAIN GRAVEL BERM & PERFORATED PIPE
STA 34+00
TEMPORARY PLUG UNTIL EXTENSION IS REQ'D
MH 2
8" DIA STORM DRAIN
TRENCH BACKFILLED WITH IMPERVIOUS SOIL
SOIL IV
STA 6+60
TEMPORARY INLET 2A
5' APPROX
PLAN VIEW
LEACHATE BARRIER & BOTTOM OF FILL AREA
TEMPORARY SOIL BERM
BACKFILL WITH GROUP D SOIL
MH 2 48" DIA MH × 6' HIGH PRECAST REINFORCED CONC. PER APWA TYPE I A1 EXCEPT USE 48" DIA FLAT SLAB COVER WITH LIFTING RINGS AND NO OPENING
18" DIA STUB W/PLUG
IE 244.8'
18" DIA PIPE @ 0.02 SLOPE
8" INLET ON NEAR SIDE PROJECTED TO CENTER OF MH. IE 245.8'
MANHOLE 2 INSTALLATION
SECTION 1/9
SCALE 1"=4'
BACKFILL WITH GROUP D ON-SITE SOILS
EXTEND LEACHATE BARRIER ACROSS TOP OF TRENCH
SOIL IV
8" DIA PIPE, PVC
CLASS D BEDDING
2'-6" MAX
CLASS C BEDDING MATERIAL AS REQUIRED
SECTION 9/7
SCALE 1"=4'
BACKFILL WITH GROUP D ON-SITE SOILS
EXTEND LEACHATE BARRIER ACROSS TOP OF TRENCH
SOIL IV
18" DIA PIPELINE, PVC CLASS II CONC.
CLASS D BEDDING
CLASS C BEDDING MATERIAL AS REQUIRED
3'-6" MAX
SECTION 10/7
SCALE 1"=4'
APPROX 10'
APPROX 5'
TEMPORARY INLET 1A
TEMPORARY SOIL BERM
TEMP PLUG
8" FLEXIBLE HOSE
TRENCH FOR 8" STORM DRAIN
8" ELBOW
SOIL IV
LEACHATE BARRIER MATERIAL
8" DIA PERFORATED PIPE
GRAVEL BERM & BACKFILL
SOIL IV
LEACHATE BARRIER
FLEXIBLE LINER
TRENCH FOR 8" LEACHATE COLLECTION PIPELINE
TRENCH FOR 18" ON SITE RUNOFF PIPELINE BACKFILL WITH IMPERVIOUS SOIL
SECTION 8/7
SCALE 1"=4'
PERMANENT SITE ROAD
LEACHATE BARRIER
8" CLEAN-OUT SIMILAR TO APWA STD PLAN NO. 45 EXCEPT MOUNT ON END OF PVC PIPE. INSTALL SO THAT TOP IS 2" TO 3" ABOVE SURFACE OF FINAL COVER
CONC. THRUST BLOCKING
APPROX. 9'
APPROX LOCATION OF FUTURE FINAL COVER SURFACE
STAKE APPROX EVERY 5' ON BOTH SIDES OF PIPE
CONC. THRUST BLOCK
155°
LEACHATE BARRIER
GRAVEL FOR GAS VENT
8" DIA PIPE, PVC
BACKFILL WITH IMPERVIOUS SOIL
8" DIA PIPE @ 0.0333 SLOPE
SECTION 7/7
SCALE 1"=4'
8" DIA FLEXIBLE HOSE LENGTH VARIES
FUTURE TEMPORARY INLET LOCATION
APPROX 10'
PLUG WHENEVER NOT CONNECTED TO INLET AND PRIOR TO COVERING WITH SOLID WASTE
FUTURE TOP OF LIFT
8" DIA EXTENSION PIPE
45°
BACKFILL WITH IMPERVIOUS SOIL
CONCRETE BLOCKING
8" DIA PIPE @ 0.0333 SLOPE
SECTION 6/7
SCALE 1"=4'
LEACHATE BARRIER
SOIL BERM 2' HIGH AT STA 6+60
FLAT
TEMPORARY INLET 1A
8" DIA EXTENSION PIPE
SOIL IV
45°
IE 251.8'
CONCRETE BLOCKING
8" DIA PIPE @ 0.0333 SLOPE
18" DIA OUTLET AT 0.056 SLOPE. IE 256.8' GROUT CHANNEL FROM INLET TO OUTLET AT CONSTANT SLOPE
SECTION MH 1 48" DIA PRECAST REINFORCED CONC. PER APWA TYPE I A1 EXCEPT USE 48" FLAT SLAB COVER WITH LIFTING RINGS & NO OPENING
BACKFILL WITH GROUP D ON-SITE SOILS
18" DIA INLET INTO NEAR SIDE. IE @ 256.8'
BEDDING MATERIAL AS REQUIRED
SECTION 5/7
SCALE 1"=4'

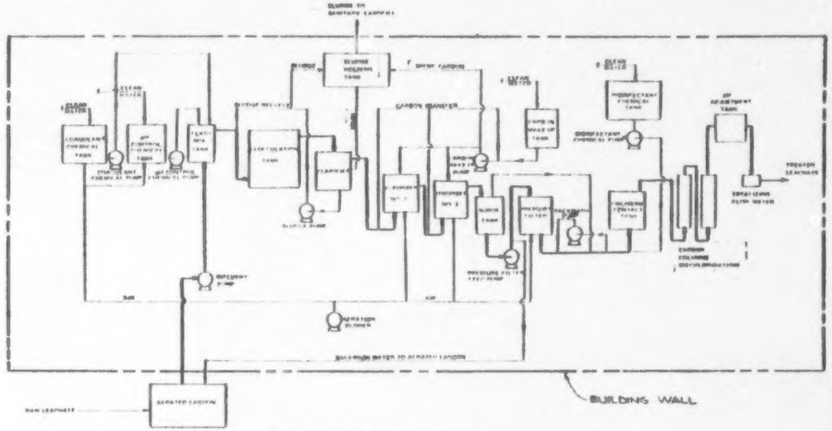
DATE	NO.	REVISION	BY	DESIGNED R.L.T. DRAWN H.A.C. CHECKED R.V.N.	APPROVED SCALE AS NOTED DATE JULY 75 JOB 73-5-486.032	Stevens, Thompson & Runyan, Inc. Engineers / Planners	SNOHOMISH COUNTY CATHCART SANITARY LANDFILL	ON-SITE RUNOFF DRAINAGE SYSTEM DETAILS	9/21


8" LEACHATE DISPOSAL PIPE
OF FILL
20HP FLOATING AERATOR
BACKWASH WATER
INFLOW
TOE OF SLOPE
AERATOR ANCHOR (4 PLACES)
10'
1/10
1/10
BLDG. FOR LEACHATE TREATMENT PLANT 16' X 48' FLOOR SPACE
℄ ROADWAY
N

LEACHATE TREATMENT SITE PLAN
NO SCALE

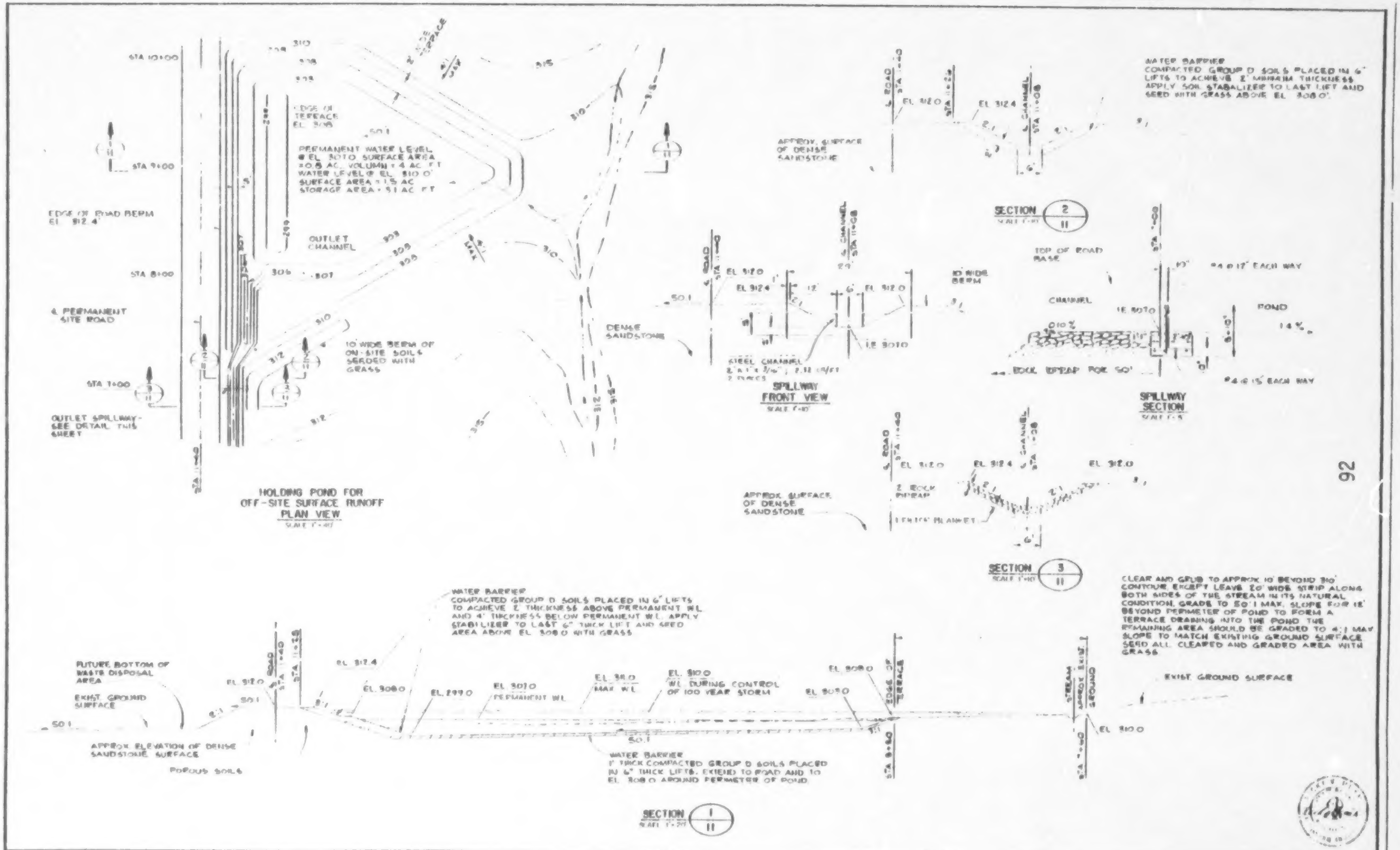

LINING OF IMPERVIOUS MEMBRANE
TOP OF DIKE
EXIST GROUND (APPROXIMATE)
100'
W.S.
6'
10'
BOTTOM LAGOON
BUILDING FOR LEACHATE TREATMENT PLANT
CONC. SPLASH PAD

SECTION 1/10
(NO SCALE)


SLUDGE TO SANITARY LANDFILL
SLUDGE HOLDING TANK
SPENT CARBON
CARBON TRANSFER
CLEAR WATER
FLOCCULATION TANK
CLARIFIER
DISINFECTANT CHEMICAL TANK
AERATED LAGOON
RAW LEACHATE
BUILDING WALL

SCHEMATIC
FLOW DIAGRAM FOR LEACHATE TREATMENT FACILITY
(NO SCALE)

DATE	NO.	REVISION	BY	B J G E C R V H	AS NOTED JULY 75 73-S-486.032	Stevens, Thompson & Runyan, Inc. Engineers/Planners PORTLAND SEATTLE SPOKANE BOISE	SNOHOMISH COUNTY CATHCART SANITARY LANDFILL	LEACHATE TREATMENT FACILITY	10/21


STA 10+00
STA 9+00
STA 8+00
STA 7+00
EDGE OF ROAD BERM
EL 312.4'
℄ PERMANENT SITE ROAD
OUTLET SPILLWAY-
SEE DETAIL THIS SHEET
EDGE OF TERRACE
EL 308
PERMANENT WATER LEVEL
@ EL 301.0 SURFACE AREA
= 0.8 AC. VOLUMN = 4 AC. FT
WATER LEVEL @ EL 310.0'
SURFACE AREA = 1.5 AC
STORAGE AREA = 51 AC. FT
OUTLET CHANNEL
10' WIDE BERM OF ON-SITE SOILS SEEDED WITH GRASS
DENSE SANDSTONE
HOLDING POND FOR
OFF-SITE SURFACE RUNOFF
PLAN VIEW
APPROX. SURFACE OF DENSE SANDSTONE
EL 312.0
EL 312.4
SECTION 2/11
STEEL CHANNEL
2' x 1' x 3/16" ; 2.12 LB/FT
2 PIECES
SPILLWAY
FRONT VIEW
SCALE 1"=10'
IE 301.0
10' WIDE BERM
TOP OF ROAD BASE
CHANNEL
0.10 %
ROCK RIPRAP FOR 50'
#4 @ 12" EACH WAY
#4 @ 15" EACH WAY
POND
14 %
SPILLWAY
SECTION
SCALE 1"=5'
2' ROCK RIPRAP
FILTER BLANKET
SECTION 3/11
FUTURE BOTTOM OF WASTE DISPOSAL AREA
EXIST. GROUND SURFACE
APPROX. ELEVATION OF DENSE SANDSTONE SURFACE
POROUS SOILS
EL 308.0
EL 299.0
EL 301.0
PERMANENT WL
EL 311.0
MAX WL
EL 310.0
WL DURING CONTROL
OF 100 YEAR STORM
EDGE OF TERRACE
STREAM
APPROX. EXIST. GROUND
SECTION 1/11

WATER BARRIER
COMPACTED GROUP D SOILS PLACED IN 6" LIFTS TO ACHIEVE 2' MINIMUM THICKNESS APPLY SOIL STABALIZER TO LAST LIFT AND SEED WITH GRASS ABOVE EL 308.0'.

CLEAR AND GRUB TO APPROX 10' BEYOND 310' CONTOUR EXCEPT LEAVE 20' WIDE STRIP ALONG BOTH SIDES OF THE STREAM IN ITS NATURAL CONDITION. GRADE TO 50:1 MAX. SLOPE FOR 12' BEYOND PERIMETER OF POND TO FORM A TERRACE DRAINING INTO THE POND THE REMAINING AREA SHOULD BE GRADED TO 4:1 MAX SLOPE TO MATCH EXISTING GROUND SURFACE SEED ALL CLEARED AND GRADED AREA WITH GRASS

WATER BARRIER
COMPACTED GROUP D SOILS PLACED IN 6" LIFTS TO ACHIEVE 2' THICKNESS ABOVE PERMANENT WL AND 4' THICKNESS BELOW PERMANENT WL. APPLY STABILIZER TO LAST 6" THICK LIFT AND SEED AREA ABOVE EL 308.0 WITH GRASS

WATER BARRIER
1' THICK COMPACTED GROUP D SOILS PLACED IN 6" THICK LIFTS. EXTEND TO ROAD AND TO EL 308.0 AROUND PERIMETER OF POND.

RTT
HAL
RVH
SCALE AS NOTED
73-S-405.032

Stevens, Thompson & Runyan, Inc.
Engineers/Planners
PORTLAND SEATTLE BOISE SPOKANE HOUSTON

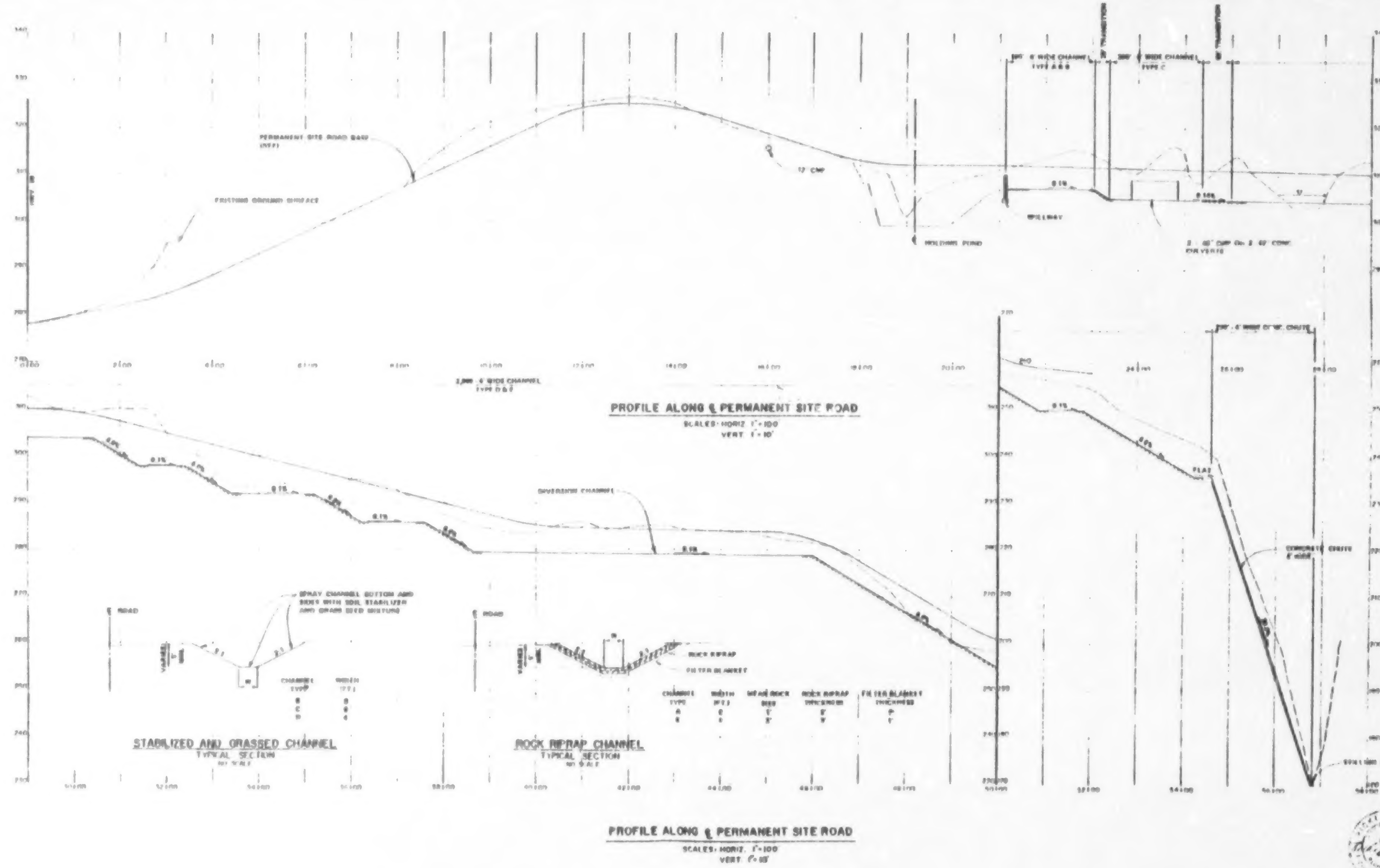
SNOHOMISH COUNTY
CATHCART SANITARY LANDFILL

OFF-SITE RUNOFF HOLDING POND

11/21

93.

93



PERMANENT SITE ROAD BASE
EXISTING GROUND SURFACE
12" CMP
HOLDING POND
SPILLWAY
6' WIDE CHANNEL TYPE A & B
6' WIDE CHANNEL TYPE C
TRANSITION
2 - 48" CMP OR 2 - 48" CONC CULVERTS
2,000' 6' WIDE CHANNEL TYPE D & E
DIVERSION CHANNEL
4' WIDE CONC. CHUTE
CONCRETE CHUTE
STILLING BASIN
FLAT
SPRAY CHANNEL BOTTOM AND SIDES WITH SOIL STABILIZER AND GRASS SEED MIXTURE
ROCK RIPRAP
FILTER BLANKET
CHANNEL TYPE
WIDTH (FT)
MEAN ROCK SIZE
ROCK RIPRAP THICKNESS
FILTER BLANKET THICKNESS
ROAD
VARIES

PROFILE ALONG ℄ PERMANENT SITE ROAD
SCALES: HORIZ. 1"=100
VERT. 1"=10'

STABILIZED AND GRASSED CHANNEL
TYPICAL SECTION
NO SCALE

ROCK RIPRAP CHANNEL
TYPICAL SECTION
NO SCALE

PROFILE ALONG ℄ PERMANENT SITE ROAD
SCALES: HORIZ. 1"=100
VERT. 1"=10'

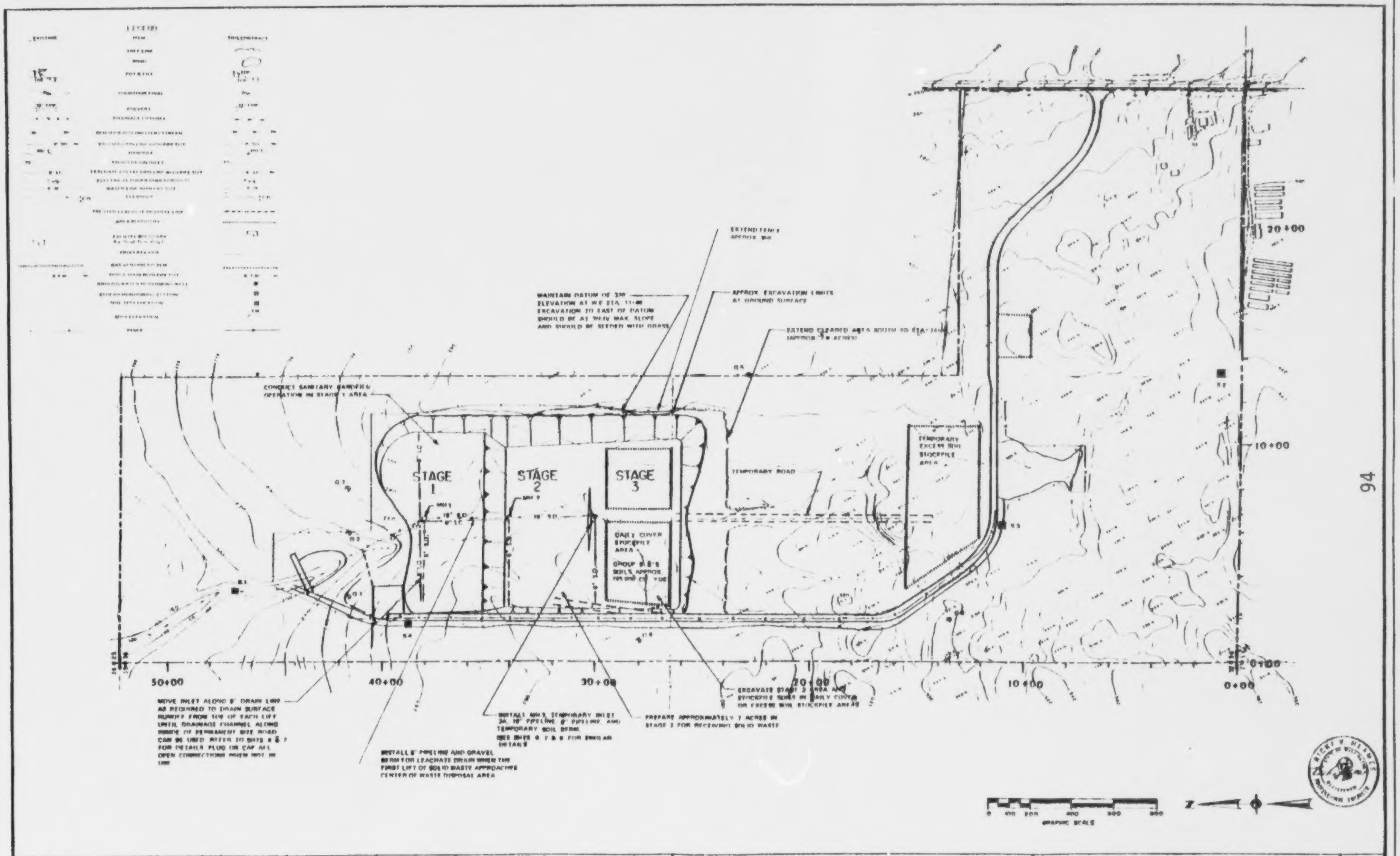
DESIGNED R.T.T.
DRAWN H.A.C.
CHECKED R.V.H.
SCALE AS SHOWN
DATE JULY 75
NO. 73-5-406012

Stevens, Thompson & Runyan, Inc.
Engineers/Planners
PORTLAND, OREGON   SEATTLE, WASHINGTON

SNOHOMISH COUNTY
CATHCART SANITARY LANDFILL

OFF-SITE RUNOFF
DIVERSION CHANNEL

12
21


LEGEND
STAGE 1
STAGE 2
STAGE 3
TEMPORARY EXCESS SOIL STOCKPILE AREA
TEMPORARY ROAD
DAILY COVER STOCKPILE AREA
EXTEND FENCE APPROX. 900
MAINTAIN DATUM OF 320 ELEVATION AT W.E STA. 11+00 EXCAVATION TO EAST OF DATUM SHOULD BE AT 3H:1V MAX. SLOPE AND SHOULD BE SEEDED WITH GRASS
APPROX. EXCAVATION LIMITS AT GROUND SURFACE
EXTEND CLEARED AREA SOUTH TO STA. 24+
CONDUCT SANITARY LANDFILL OPERATION IN STAGE 1 AREA
MOVE INLET ALONG 8" DRAIN LINE AS REQUIRED TO DRAIN SURFACE RUNOFF FROM TOE OF EACH LIFT UNTIL DRAINAGE CHANNEL ALONG INSIDE OF PERMANENT SITE ROAD CAN BE USED. REFER TO SHTS 6 & 7 FOR DETAILS. PLUG OR CAP ALL OPEN CONNECTIONS WHEN NOT IN USE
INSTALL 8" PIPELINE AND GRAVEL BERM FOR LEACHATE DRAIN WHEN THE FIRST LIFT OF SOLID WASTE APPROACHES CENTER OF WASTE DISPOSAL AREA
INSTALL MH 3, TEMPORARY INLET 3A, 10" PIPELINE, 8" PIPELINE, AND TEMPORARY SOIL BERM. SEE SHTS 6, 7 & 8 FOR SIMILAR DETAILS
PREPARE APPROXIMATELY 7 ACRES IN STAGE 2 FOR RECEIVING SOLID WASTE
EXCAVATE STAGE 3 AREA AND STOCKPILE SOILS IN DAILY COVER OR EXCESS SOIL STOCKPILE AREAS
50+00
40+00
30+00
20+00
10+00
0+00
20+00
10+00
0+00
GRAPHIC SCALE
0
100
200
400
600
800
N
94

DATE	NO.	REVISION	BY	DESIGNED R.T.T. DRAWN R.A.C. CHECKED R.V.H.	APPROVED [illegible] SCALE AS SHOWN DATE JULY 75 FILE 73-8-486.032	**Stevens, Thompson & Runyan, Inc.** Engineers / Planners PORTLAND SEATTLE BOISE SPOKANE ANCHORAGE	SNOHOMISH COUNTY CATHCART SANITARY LANDFILL

PHASE II
STAGE 1 LANDFILL AND STAGE 2
PREPARATION PLAN

13 / 21

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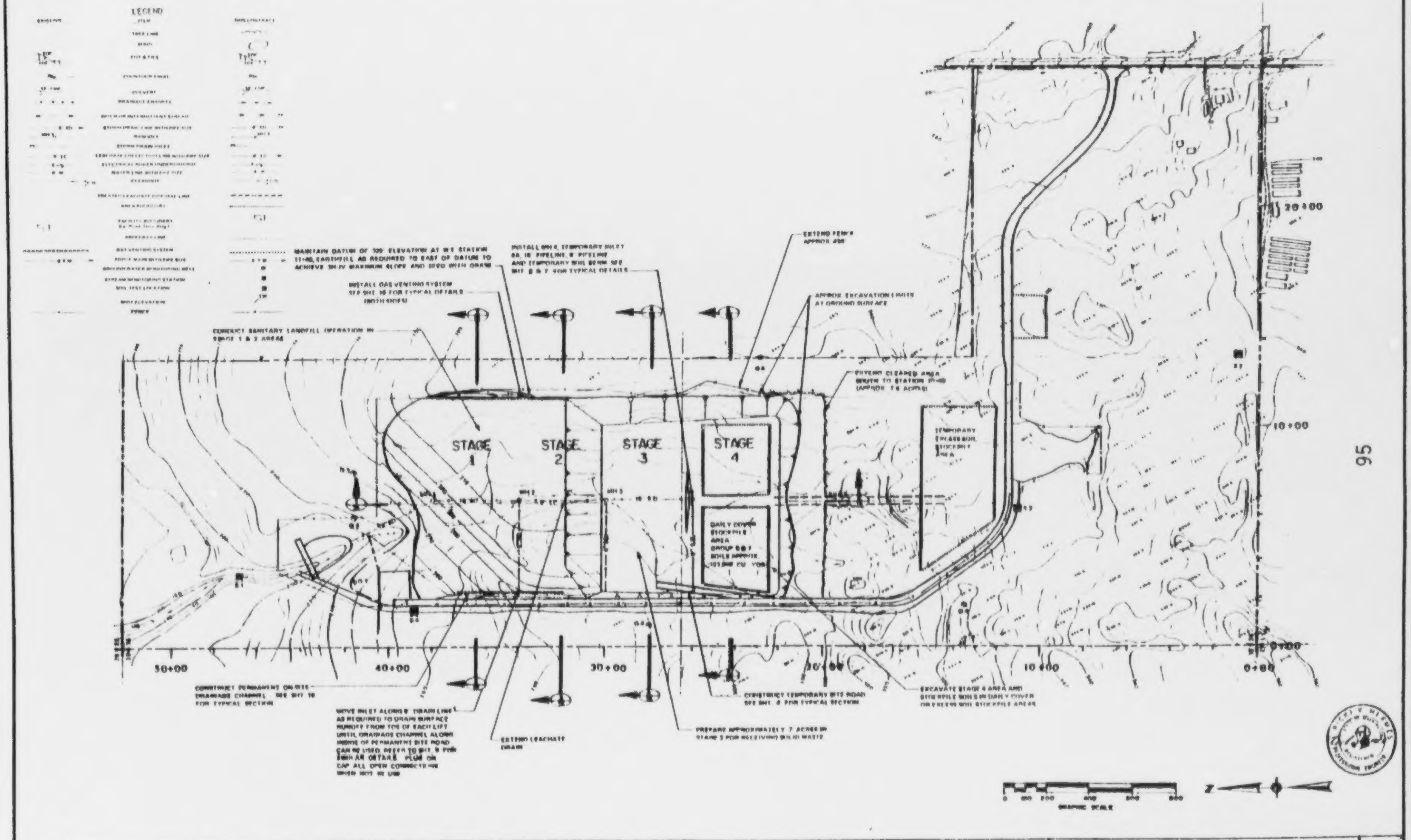
LEGEND
MAINTAIN DATUM OF 320' ELEVATION AT W.T. STATION 11+40, EARTHFILL AS REQUIRED TO EAST OF DATUM TO ACHIEVE 3H:1V MAXIMUM SLOPE AND SEED WITH GRASS
INSTALL MH 6, TEMPORARY INLET 6A, 16" PIPELINE, 8" PIPELINE AND TEMPORARY SOIL BERM SEE SHT. 6 & 7 FOR TYPICAL DETAILS
EXTEND FENCE APPROX. 400'
INSTALL GAS VENTING SYSTEM SEE SHT. 16 FOR TYPICAL DETAILS (BOTH SIDES)
APPROX. EXCAVATION LIMITS AT GROUND SURFACE
CONDUCT SANITARY LANDFILL OPERATION IN STAGE 1 & 2 AREAS
EXTEND CLEARED AREA SOUTH TO STATION 11+40 (APPROX. 7.0 ACRES)
TEMPORARY EXCESS SOIL STOCKPILE AREA
STAGE 1
STAGE 2
STAGE 3
STAGE 4
DAILY COVER STOCKPILE AREA GROUP 8 & 9 SOILS APPROX. 103,000 CU. YDS.
50+00
40+00
30+00
20+00
10+00
0+00
CONSTRUCT PERMANENT ON-SITE DRAINAGE CHANNEL SEE SHT. 10 FOR TYPICAL SECTION
MOVE INLET ALONG 8" DRAIN LINE AS REQUIRED TO DRAIN SURFACE RUNOFF FROM TOE OF EACH LIFT UNTIL DRAINAGE CHANNEL ALONG INSIDE OF PERMANENT SITE ROAD CAN BE USED. REFER TO SHT. 8 FOR SIMILAR DETAILS. PLUG OR CAP ALL OPEN CONNECTIONS WHEN NOT IN USE
EXTEND LEACHATE DRAIN
PREPARE APPROXIMATELY 7 ACRES IN STAGE 3 FOR RECEIVING SOLID WASTE
CONSTRUCT TEMPORARY SITE ROAD SEE SHT. 8 FOR TYPICAL SECTION
EXCAVATE STAGE 4 AREA AND STOCKPILE SOILS IN DAILY COVER OR EXCESS SOIL STOCKPILE AREAS
0
100
200
400
600
800
GRAPHIC SCALE
N

DATE	NO.	REVISION	BY	DESIGNED R.T.T.	APPROVED	Stevens, Thompson & Runyan, Inc. Engineers/Planners	SNOHOMISH COUNTY	PHASE II	14/21
				DRAWN H.A.C.	SCALE AS SHOWN DATE JULY 75	PORTLAND SEATTLE BOISE SPOKANE HOUSTON	CATHCART SANITARY LANFILL	STAGE 1 & 2 LANDFILL AND STAGE 3 PREPARATION PLAN	
				CHECKED R.V.H.	FILE 75-8-498.032				

95

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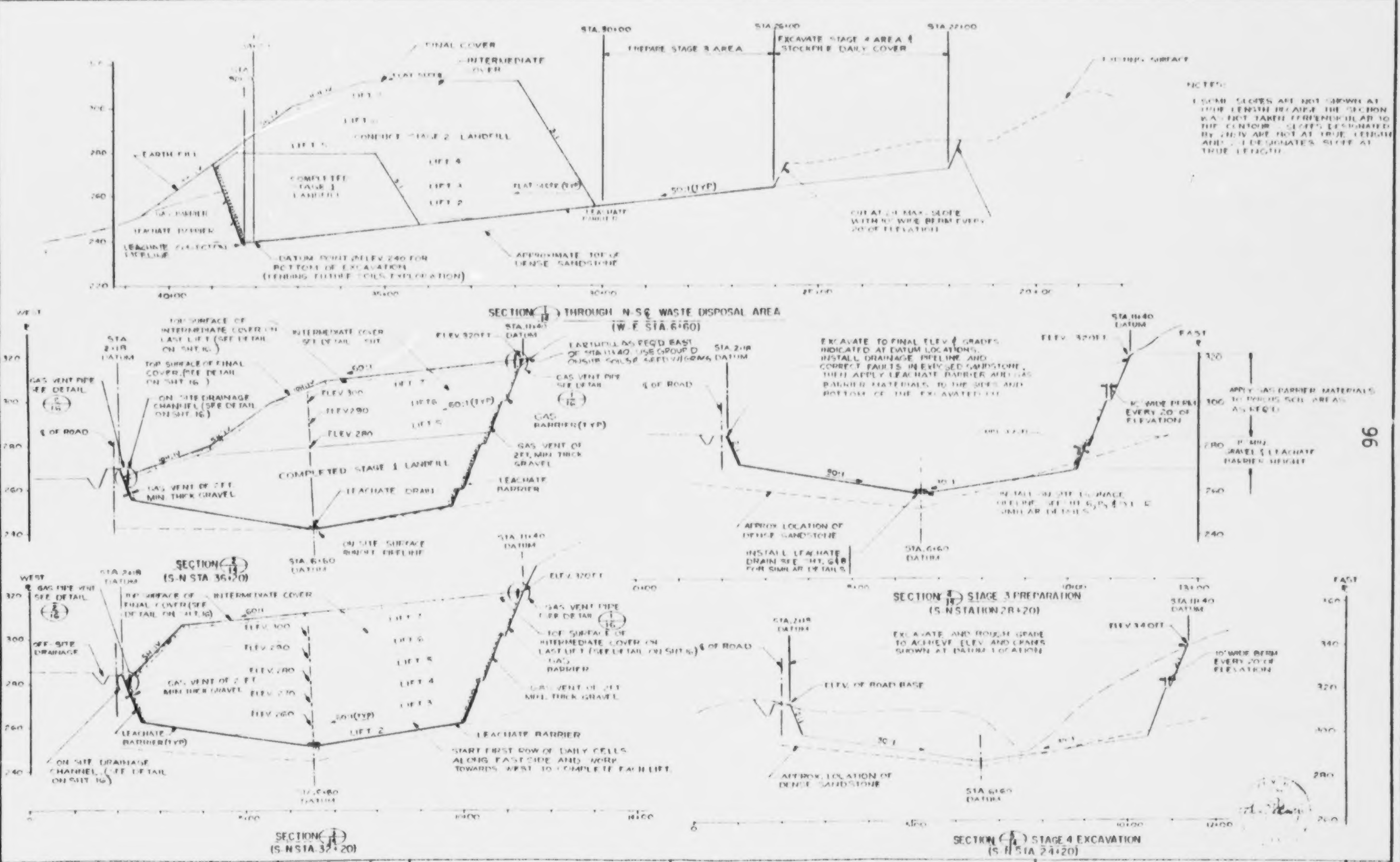
96


STA. 30+00
STA. 26+00
STA. 22+00
FINAL COVER
INTERMEDIATE COVER
FLAT SLOPE
PREPARE STAGE 3 AREA
EXCAVATE STAGE 4 AREA & STOCKPILE DAILY COVER
EXISTING SURFACE
LIFT 7
LIFT 6
LIFT 5
LIFT 4
LIFT 3
LIFT 2
CONDUCT STAGE 2 LANDFILL
COMPLETED STAGE 1 LANDFILL
EARTH FILL
GAS BARRIER
LEACHATE BARRIER
LEACHATE COLLECTION PIPELINE
FLAT SLOPE (TYP)
50:1 (TYP)
CUT AT 2:1 MAX. SLOPE WITH 10' WIDE BERM EVERY 20' OF ELEVATION
DATUM POINT @ ELEV. 240 FOR BOTTOM OF EXCAVATION (PENDING FUTURE SOILS EXPLORATION)
APPROXIMATE TOP OF DENSE SANDSTONE
40+00
35+00
30+00
25+00
20+00
SECTION THROUGH N-S ℄ WASTE DISPOSAL AREA (W-E STA. 6+60)
WEST ℄
EAST ℄
STA. 2+18 DATUM
STA. 11+40 DATUM
STA. 6+60 DATUM
TOP SURFACE OF INTERMEDIATE COVER ON LAST LIFT (SEE DETAIL ON SHT. 16)
TOP SURFACE OF FINAL COVER (SEE DETAIL ON SHT. 16)
INTERMEDIATE COVER SEE DETAIL SHT.
GAS VENT PIPE SEE DETAIL
ON SITE DRAINAGE CHANNEL (SEE DETAIL ON SHT. 16)
℄ OF ROAD
ELEV. 320 FT
ELEV. 300
ELEV. 290
ELEV. 280
ELEV. 270
ELEV. 260
60:1
60:1 (TYP)
EARTHFILL AS REQ'D EAST OF STA. 11+40. USE GROUP D ONSITE SOILS & SEED W/GRASS
GAS BARRIER (TYP)
GAS VENT OF 2 FT. MIN. THICK GRAVEL
COMPLETED STAGE 1 LANDFILL
LEACHATE DRAIN
LEACHATE BARRIER
ON SITE SURFACE RUNOFF PIPELINE
SECTION (S-N STA. 36+20)
OFF-SITE DRAINAGE
START FIRST ROW OF DAILY CELLS ALONG EAST SIDE AND WORK TOWARDS WEST TO COMPLETE EACH LIFT.
ON SITE DRAINAGE CHANNEL (SEE DETAIL ON SHT. 16)
LEACHATE BARRIER (TYP)
SECTION (S-N STA. 32+20)
10' WIDE BERM EVERY 20' OF ELEVATION
APPLY GAS BARRIER MATERIALS TO POROUS SOIL AREAS AS REQ'D
1' MIN. GRAVEL & LEACHATE BARRIER HEIGHT
30:1
APPROX. LOCATION OF DENSE SANDSTONE
INSTALL LEACHATE DRAIN SEE SHT. 6 & 8 FOR SIMILAR DETAILS
INSTALL ON SITE DRAINAGE PIPELINE SEE SHT. 6, 8 FOR SIMILAR DETAILS
SECTION STAGE 3 PREPARATION (S-N STATION 28+20)
ELEV. 340 FT
ELEV. OF ROAD BASE
SECTION STAGE 4 EXCAVATION (S-N STA. 24+20)
320
300
280
260
240
220
340
360

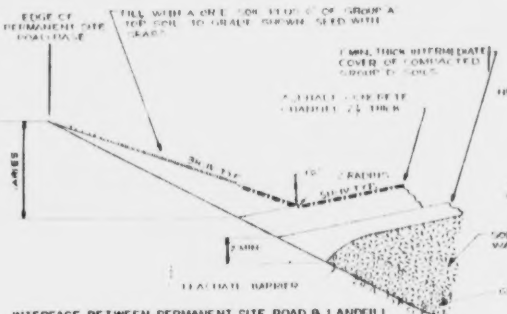
NOTES:

1. SOME SLOPES ARE NOT SHOWN AT TRUE LENGTH BECAUSE THE SECTION WAS NOT TAKEN PERPENDICULAR TO THE CONTOUR. SLOPES DESIGNATED BY 2H:1V ARE NOT AT TRUE LENGTH AND 2:1 DESIGNATES SLOPE AT TRUE LENGTH.

EXCAVATE TO FINAL ELEV. & GRADES INDICATED AT DATUM LOCATIONS. INSTALL DRAINAGE PIPELINE AND CORRECT FAULTS IN EXPOSED SANDSTONE, THEN APPLY LEACHATE BARRIER AND GAS BARRIER MATERIALS TO THE SIDES AND BOTTOM OF THE EXCAVATED CUT.

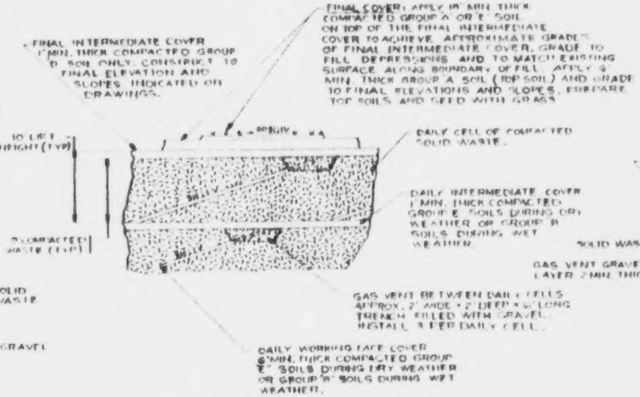
EXCAVATE AND ROUGH GRADE TO ACHIEVE ELEV. AND GRADES SHOWN AT DATUM LOCATION

R.T.T. G.E.C. RVH	AS SHOWN · JULY 75 73-5-486.032	Stevens, Thompson & Runyan, Inc. Engineers / Planners	SNOHOMISH COUNTY CATHCART SANITARY LANDFILL	STAGE 1 & 2 LANDFILL AND STAGE 3 PREPARATION DETAILS	15 21

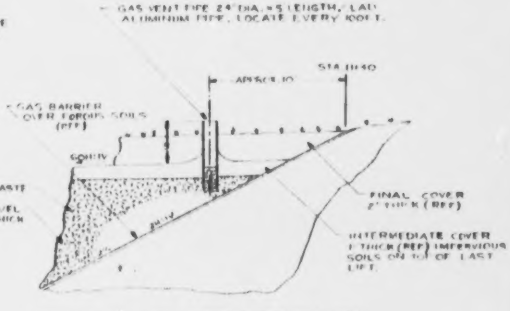

EDGE OF PERMANENT SITE ROAD BASE
FILL WITH A OR E SOIL PLUS 6" OF GROUP A TOP SOIL TO GRADE SHOWN. SEED WITH GRASS
1' MIN. THICK INTERMEDIATE COVER OF COMPACTED GROUP D SOILS
ASPHALT CONCRETE CHANNEL 2½" THICK
VARIES
3H:1V TYP
1.0'
2' RADIUS
5H:1V TYP
2' MIN
LEACHATE BARRIER
SOLID WASTE
GRAVEL

INTERFACE BETWEEN PERMANENT SITE ROAD & LANDFILL

DETAIL
(SCALE 1"=4')


FINAL INTERMEDIATE COVER 1' MIN. THICK COMPACTED GROUP D SOIL ONLY. CONSTRUCT TO FINAL ELEVATION AND SLOPES INDICATED ON DRAWINGS.
FINAL COVER: APPLY 18" MIN. THICK COMPACTED GROUP 'A' OR 'E' SOIL ON TOP OF THE FINAL INTERMEDIATE COVER TO ACHIEVE APPROXIMATE GRADES OF FINAL INTERMEDIATE COVER. GRADE TO FILL DEPRESSIONS AND TO MATCH EXISTING SURFACE ALONG BOUNDARY OF FILL. APPLY 6" MIN. THICK GROUP A SOIL (TOP SOIL) AND GRADE TO FINAL ELEVATIONS AND SLOPES. PREPARE TOP SOILS AND SEED WITH GRASS
10' LIFT HEIGHT (TYP)
9' COMPACTED WASTE (TYP)
DAILY CELL OF COMPACTED SOLID WASTE.
DAILY INTERMEDIATE COVER 1' MIN. THICK COMPACTED GROUP E SOILS DURING DRY WEATHER OR GROUP B SOILS DURING WET WEATHER.
GAS VENT BETWEEN DAILY CELLS APPROX. 2' WIDE × 2' DEEP × 6' LONG TRENCH FILLED WITH GRAVEL. INSTALL 3 PER DAILY CELL.
DAILY WORKING FACE COVER 6" MIN. THICK COMPACTED GROUP 'E' SOILS DURING DRY WEATHER OR GROUP 'B' SOILS DURING WET WEATHER.

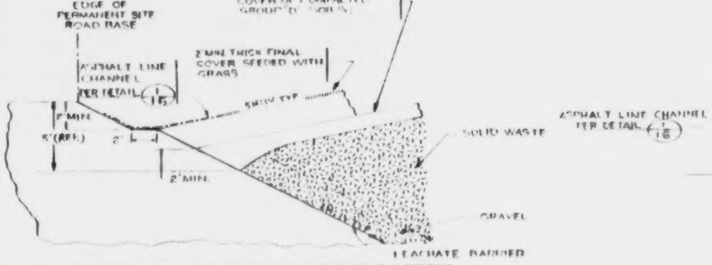
DAILY AND FINAL COVER CONSTRUCTION
(SCALE: 1"=8')


GAS VENT PIPE 24" DIA. × 5' LENGTH, CAP ALUMINUM PIPE. LOCATE EVERY 100 FT.
STA 11+40
APPROX. 10'
GAS BARRIER OVER POROUS SOILS (REF)
50H:1V
SOLID WASTE
GAS VENT GRAVEL LAYER 2' MIN. THICK
3H:1V
FINAL COVER 2' THICK (REF)
INTERMEDIATE COVER 1' THICK (REF) IMPERVIOUS SOILS ON TOP OF LAST LIFT.

GAS VENTING SYSTEM - EAST SIDE OF FILL AREA

DETAIL

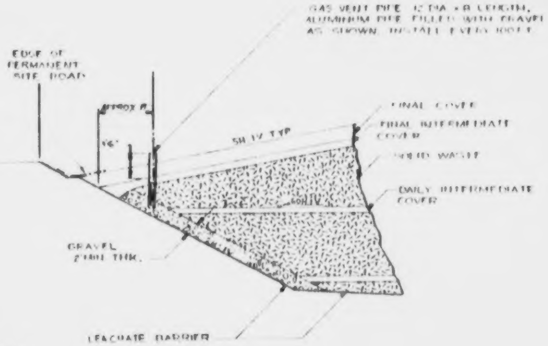
(SCALE: 1"=4')

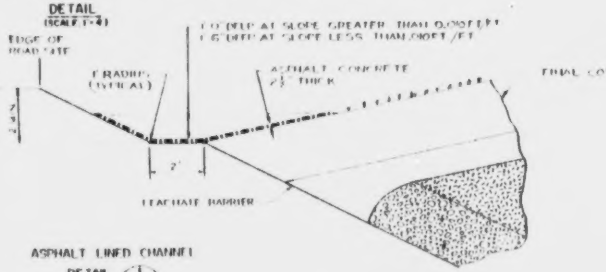

EDGE OF PERMANENT SITE ROAD BASE
1' MIN. THICK INTERMEDIATE COVER OF COMPACTED GROUP 'D' SOILS.
ASPHALT LINE CHANNEL PER DETAIL 1/15
2' MIN. THICK FINAL COVER SEEDED WITH GRASS
5H:1V TYP
2' MIN.
5' (REF.)
2'
2' MIN.
SOLID WASTE
3H:1V TYP
GRAVEL
LEACHATE BARRIER

ASPHALT LINE CHANNEL PER DETAIL 1/15

INTERFACE BETWEEN PERMANENT SITE ROAD & LANDFILL

DETAIL
(SCALE 1"=4')


GAS VENT PIPE 12" DIA. × 8' LENGTH, ALUMINUM PIPE FILLED WITH GRAVEL AS SHOWN. INSTALL EVERY 100 FT.
EDGE OF PERMANENT SITE ROAD
APPROX 8'
16'
5H:1V TYP
FINAL COVER
FINAL INTERMEDIATE COVER
SOLID WASTE
50H:1V
DAILY INTERMEDIATE COVER
GRAVEL 2' MIN. THK.
LEACHATE BARRIER


EDGE OF ROAD SITE
1.0' DEEP AT SLOPE GREATER THAN 0.010 FT/FT
1.5' DEEP AT SLOPE LESS THAN .010 FT/FT
1' RADIUS (TYPICAL)
ASPHALT CONCRETE 2½" THICK
FINAL COVER
2'
LEACHATE BARRIER

GAS VENTING SYSTEM - WEST SIDE FILL AREA

DETAIL 2/15

(SCALE 1"=4')

ASPHALT LINED CHANNEL

DETAIL 1/15

(SCALE 1"=2')

DATE	REV	REVISION	BY	DESIGNED R.T.T.	APPROVED	Stevens, Thompson & Runyan, Inc.	SNOHOMISH COUNTY	DAILY COVER, FINAL COVER &	16
				DRAWN G.F.C.	SCALE AS SHOWN DATE JULY 75	Engineers / Planners	CATHCART SANITARY LANDFILL	GAS CONTROLS	21
				CHECKED R.V.H.	JOB 73-S-486.032				

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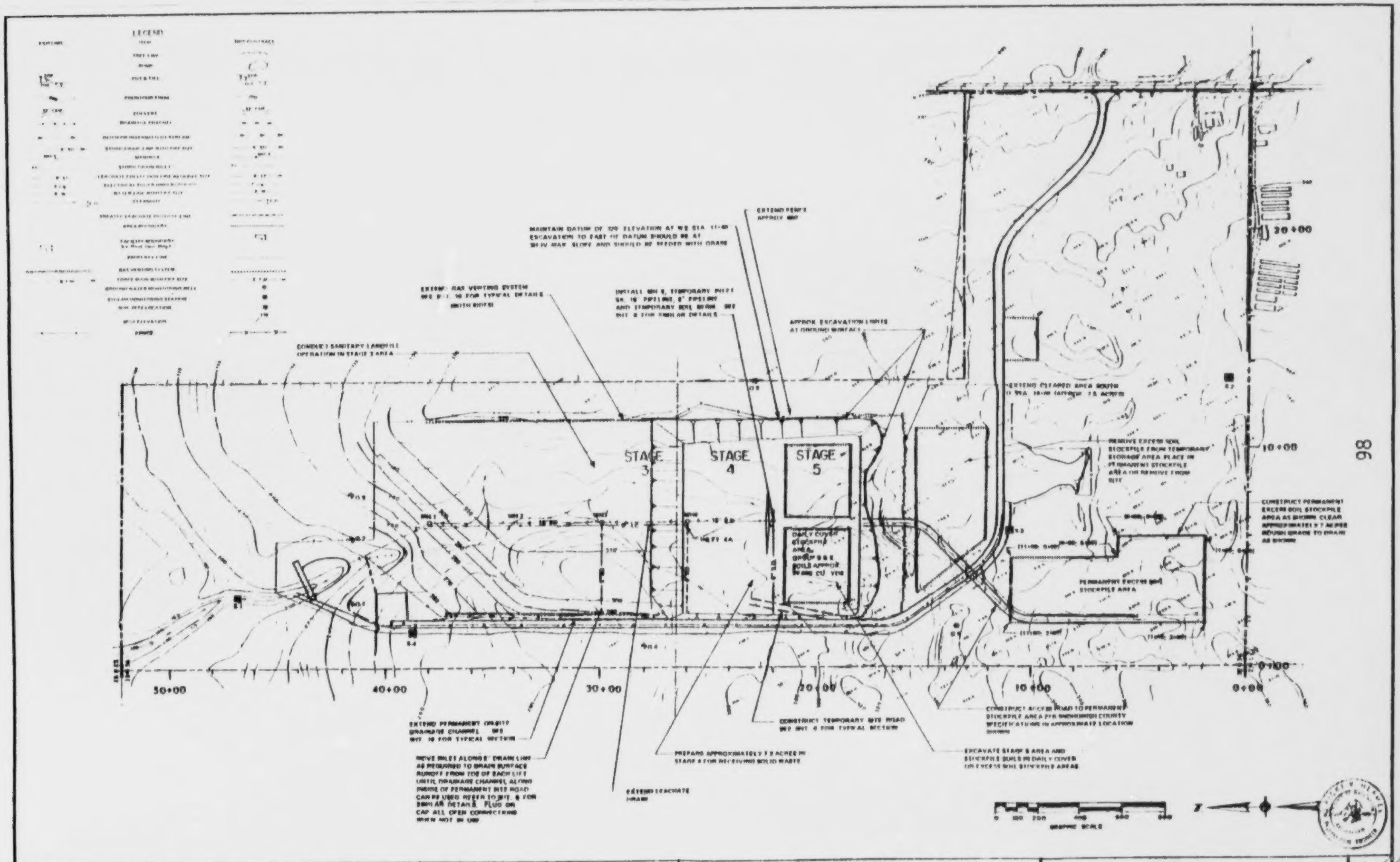
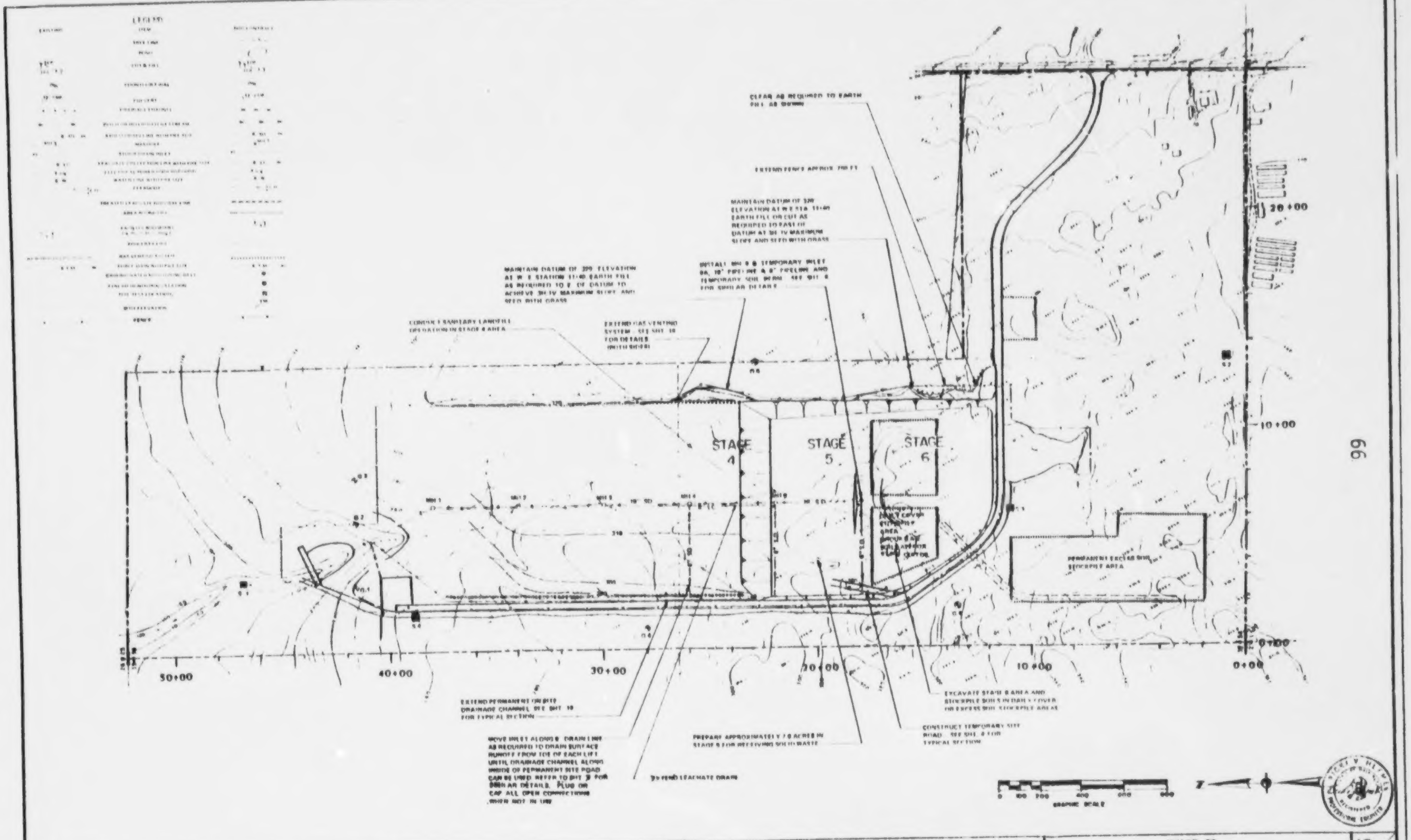

LEGEND
STAGE 3
STAGE 4
STAGE 5
CONDUCT SANITARY LANDFILL OPERATION IN STAGE 3 AREA
EXTEND GAS VENTING SYSTEM SEE DWG. 16 FOR TYPICAL DETAILS (WITH RISERS)
MAINTAIN DATUM OF 120 ELEVATION AT WE STA. 11+00 EXCAVATION TO EAST OF DATUM SHOULD BE AT 3H:1V MAX. SLOPE AND SHOULD BE SEEDED WITH GRASS
INSTALL MH 8, TEMPORARY INLET SA, 18" PIPELINE, 8" PIPELINE AND TEMPORARY SOIL BERM SEE DWG. 8 FOR SIMILAR DETAILS
EXTEND FENCE APPROX 800'
APPROX. EXCAVATION LIMITS AT GROUND SURFACE
EXTEND CLEARED AREA SOUTH TO STA. 10+00 (APPROX. 7.5 ACRES)
REMOVE EXCESS SOIL STOCKPILE FROM TEMPORARY STORAGE AREA PLACE IN PERMANENT STOCKPILE AREA OR REMOVE FROM SITE
CONSTRUCT PERMANENT EXCESS SOIL STOCKPILE AREA AS SHOWN. CLEAR APPROXIMATELY 9.7 ACRES ROUGH GRADE TO DRAIN AS SHOWN
PERMANENT EXCESS SOIL STOCKPILE AREA
DAILY COVER STOCKPILE AREA
20+00
10+00
0+00
30+00
40+00
50+00
EXTEND PERMANENT ONSITE DRAINAGE CHANNEL SEE DWG. 16 FOR TYPICAL SECTION
MOVE INLET ALONG 8" DRAIN LINE AS REQUIRED TO DRAIN SURFACE RUNOFF FROM TOE OF EACH LIFT UNTIL DRAINAGE CHANNEL ALONG INSIDE OF PERMANENT SITE ROAD CAN BE USED. REFER TO DWG. 8 FOR SIMILAR DETAILS. PLUG OR CAP ALL OPEN CONNECTIONS WHEN NOT IN USE
EXTEND LEACHATE DRAIN
PREPARE APPROXIMATELY 7.3 ACRES IN STAGE 4 FOR RECEIVING SOLID WASTE
CONSTRUCT TEMPORARY SITE ROAD SEE DWG. 6 FOR TYPICAL SECTION
EXCAVATE STAGE 5 AREA AND STOCKPILE SOILS IN DAILY COVER OR EXCESS SOIL STOCKPILE AREAS
CONSTRUCT ACCESS ROAD TO PERMANENT STOCKPILE AREA PER SNOHOMISH COUNTY SPECIFICATIONS IN APPROXIMATE LOCATION SHOWN
0
100
200
400
600
800
GRAPHIC SCALE
N

DATE	NO	REVISION	BY	DESIGNED R.T.T. DRAWN H.A.C. CHECKED R.V.H.	APPROVED [illegible] SCALE AS SHOWN DATE JULY 78 FILE 73-5-486.032	Stevens, Thompson & Runyan, Inc. Engineers / Planners PORTLAND SEATTLE BOISE SPOKANE HOUSTON	SNOHOMISH COUNTY CATHART SANITARY LANFILL	PHASE II STAGE 3 LANDFILL AND STAGE 4 PREPARATION PLAN	17/21


LEGEND
CLEAR AS REQUIRED TO EARTH FILL AS SHOWN
EXTEND FENCE APPROX 700 FT
MAINTAIN DATUM OF 320 ELEVATION AT W E STA 11+40 EARTH FILL OR CUT AS REQUIRED TO EAST OF DATUM AT 3H 1V MAXIMUM SLOPE AND SEED WITH GRASS
MAINTAIN DATUM OF 320 ELEVATION AT W E STATION 11+40 EARTH FILL AS REQUIRED TO E OF DATUM TO ACHIEVE 3H 1V MAXIMUM SLOPE AND SEED WITH GRASS
INSTALL MH 8 & TEMPORARY INLET 8A, 18" PIPELINE & 8" PIPELINE AND TEMPORARY SOIL BERM SEE SHT 8 FOR SIMILAR DETAILS
CONDUCT SANITARY LANDFILL OPERATION IN STAGE 4 AREA
EXTEND GAS VENTING SYSTEM SEE SHT 10 FOR DETAILS (WITH SHIRI)
STAGE 4
STAGE 5
STAGE 6
PERMANENT EXCESS SOIL STOCKPILE AREA
50+00
40+00
30+00
20+00
10+00
0+00
EXTEND PERMANENT ONSITE DRAINAGE CHANNEL SEE SHT 10 FOR TYPICAL SECTION
MOVE INLET ALONG 8 DRAIN LINE AS REQUIRED TO DRAIN SURFACE RUNOFF FROM TOE OF EACH LIFT UNTIL DRAINAGE CHANNEL ALONG INSIDE OF PERMANENT SITE ROAD CAN BE USED REFER TO SHT 9 FOR SIMILAR DETAILS. PLUG OR CAP ALL OPEN CONNECTIONS WHEN NOT IN USE
EXTEND LEACHATE DRAIN
PREPARE APPROXIMATELY 7.0 ACRES IN STAGE 5 FOR RECEIVING SOLID WASTE
EXCAVATE STAGE 5 AREA AND STOCKPILE SOILS IN DAILY COVER OR EXCESS SOIL STOCKPILE AREAS
CONSTRUCT TEMPORARY SITE ROAD SEE SHT 4 FOR TYPICAL SECTION
0 100 200 400 600 800
GRAPHIC SCALE
N

DESIGNED R.T.T	APPROVED	Stevens, Thompson & Runyan, Inc. Engineers / Planners	SNOHOMISH COUNTY	PHASE II	18
DRAWN G.E.C	SCALE AS SHOWN DATE JULY 75	PORTLAND SEATTLE BOISE SPOKANE HOUSTON	CATHCART SANITARY LANDFILL	STAGE 4 LANDFILL AND STAGE 5 PREPARATION PLAN	21
CHECKED RVM	FILE 73-S 486 032				

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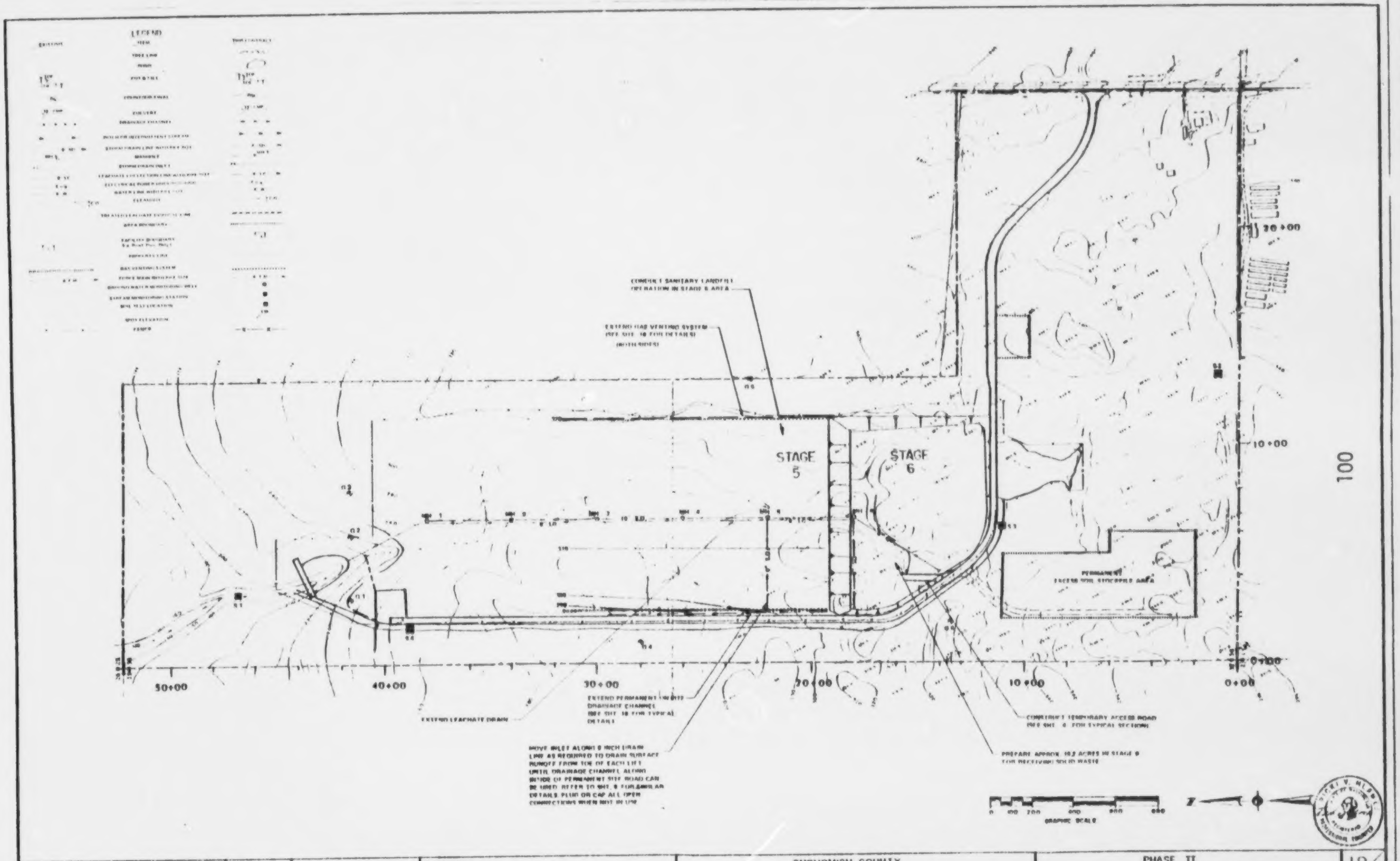

LEGEND
EXISTING
ITEM
THIS CONTRACT
TREE LINE
ROAD
CULVERT
DRAINAGE CHANNEL
MANHOLE
ELEVATION
AREA BOUNDARY
PROPERTY LINE
GAS VENTING SYSTEM
SOIL TEST LOCATION
SPOT ELEVATION
FENCE
STAGE 5
STAGE 6
PERMANENT EXCESS SOIL STOCKPILE AREA
CONDUCT SANITARY LANDFILL OPERATION IN STAGE 5 AREA
EXTEND GAS VENTING SYSTEM (SEE SHT. 10 FOR DETAILS) (BOTH SIDES)
EXTEND LEACHATE DRAIN
EXTEND PERMANENT INSITE DRAINAGE CHANNEL (SEE SHT. 10 FOR TYPICAL DETAIL)
MOVE INLET ALONG 8 INCH DRAIN LINE AS REQUIRED TO DRAIN SURFACE RUNOFF FROM TOE OF EACH LIFT UNTIL DRAINAGE CHANNEL ALONG INSIDE OF PERMANENT SITE ROAD CAN BE USED. REFER TO SHT. 8 FOR SIMILAR DETAILS. PLUG OR CAP ALL OPEN CONNECTIONS WHEN NOT IN USE
CONSTRUCT TEMPORARY ACCESS ROAD (SEE SHT. 6 FOR TYPICAL SECTION)
PREPARE APPROX. 10.2 ACRES IN STAGE 6 FOR RECEIVING SOLID WASTE
0+00
10+00
20+00
30+00
40+00
50+00
0 100 200 400 600 800
GRAPHIC SCALE

100

DATE	NO.	REVISION	BY

DESIGNED R.T.T.
DRAWN G.F.C.
CHECKED R.V.H.

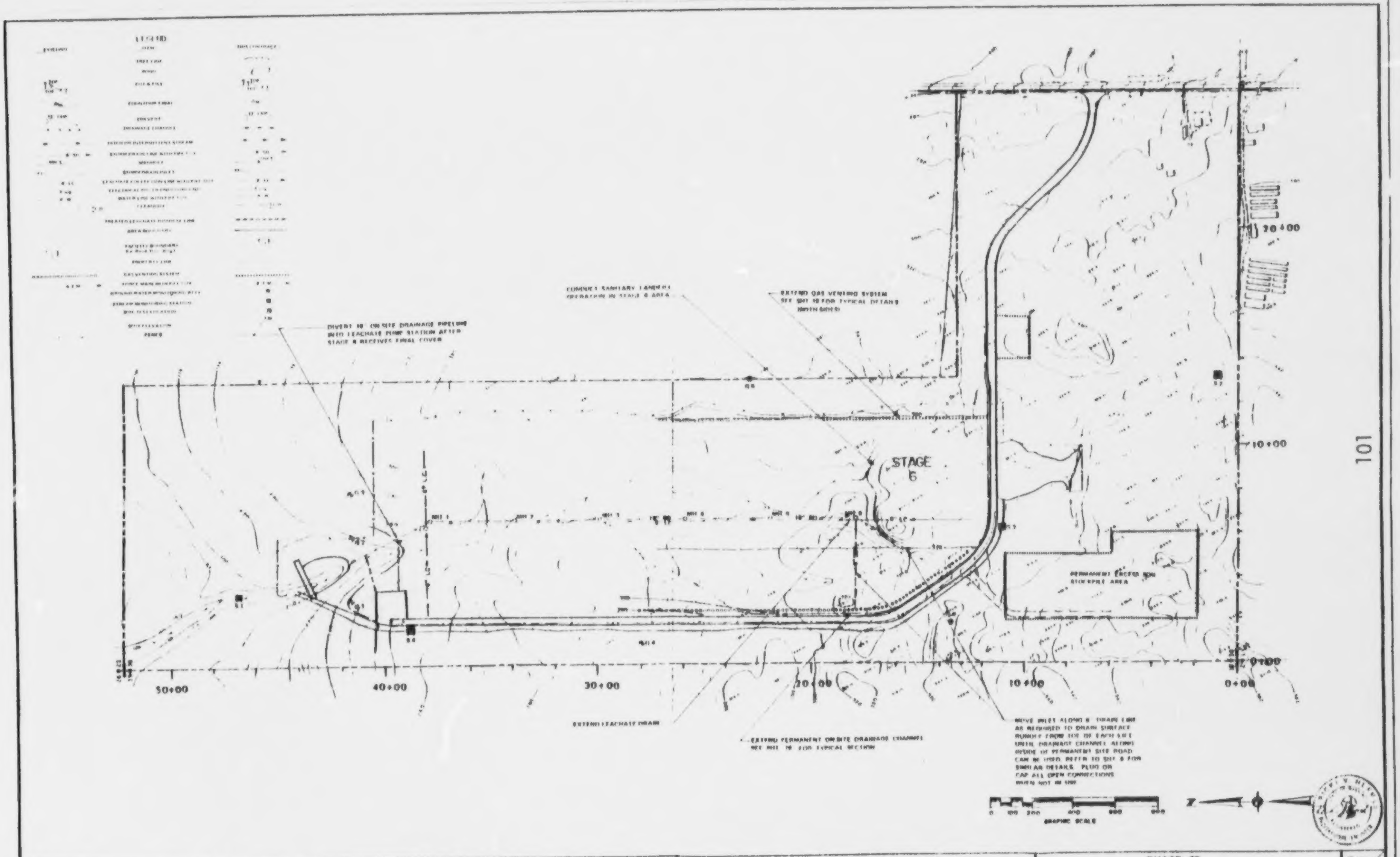
APPROVED
SCALE AS SHOWN DATE JULY 75
JOB 75-5-466 032

Stevens, Thompson & Runyan, Inc.
Engineers / Planners
PORTLAND SEATTLE BOISE SPOKANE

SNOHOMISH COUNTY
CATHART SANITARY LANDFILL

PHASE II
STAGE 5 LANDFILL AND STAGE 6 PREPARATION PLAN

19/21

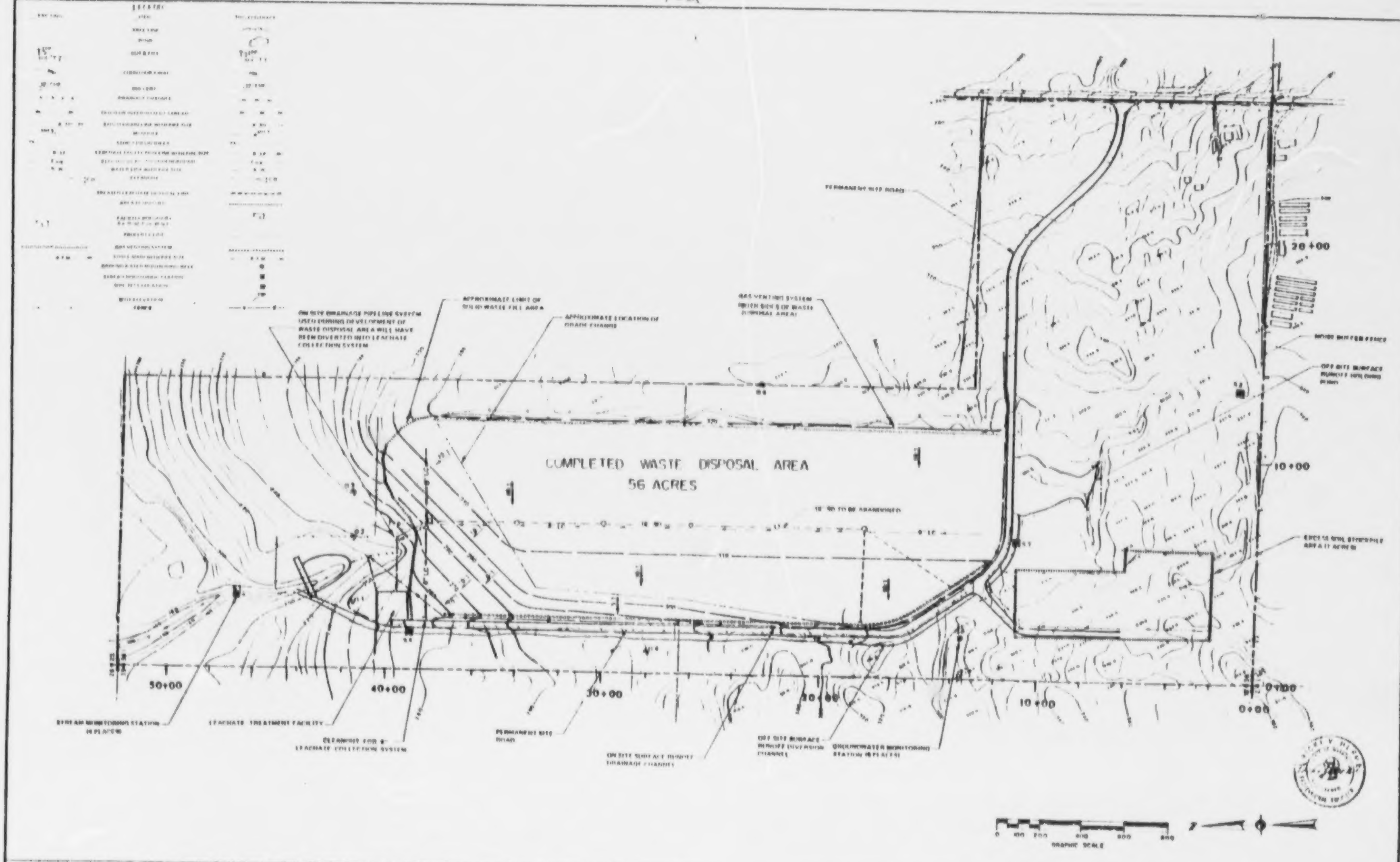

LEGEND
STAGE 6
CONDUCT SANITARY LANDFILL OPERATION IN STAGE 6 AREA
EXTEND GAS VENTING SYSTEM SEE SHT 18 FOR TYPICAL DETAILS (BOTH SIDES)
DIVERT 18" ONSITE DRAINAGE PIPELINE INTO LEACHATE PUMP STATION AFTER STAGE 6 RECEIVES FINAL COVER
EXTEND LEACHATE DRAIN
EXTEND PERMANENT ONSITE DRAINAGE CHANNEL SEE SHT 18 FOR TYPICAL SECTION
MOVE INLET ALONG 8" DRAIN LINE AS REQUIRED TO DRAIN SURFACE RUNOFF FROM TOP OF EACH LIFT UNTIL DRAINAGE CHANNEL ALONG INSIDE OF PERMANENT SITE ROAD CAN BE USED. REFER TO SHT 8 FOR SIMILAR DETAILS. PLUG OR CAP ALL OPEN CONNECTIONS WHEN NOT IN USE
PERMANENT EXCESS SOIL STOCKPILE AREA
0+00
10+00
20+00
30+00
40+00
50+00
0 100 200 400 600 800
GRAPHIC SCALE
N

DESIGNED R T T DRAWN G E C CHECKED R V H	APPROVED SCALE AS SHOWN DATE JULY 75 FILE 73-9-486.032	Stevens, Thompson & Runyan, Inc. Engineers / Planners PORTLAND SEATTLE BOISE SPOKANE HOUSTON	SNOHOMISH COUNTY CATHCART SANITARY LANDFILL

PHASE II
STAGE 6 LANDFILL PLAN

20/21

102


COMPLETED WASTE DISPOSAL AREA
56 ACRES
ON SITE DRAINAGE PIPELINE SYSTEM USED DURING DEVELOPMENT OF WASTE DISPOSAL AREA WILL HAVE BEEN DIVERTED INTO LEACHATE COLLECTION SYSTEM
APPROXIMATE LIMIT OF SOLID WASTE FILL AREA
APPROXIMATE LOCATION OF GRADE CHANGE
GAS VENTING SYSTEM (WITH SIDES OF WASTE DISPOSAL AREA)
PERMANENT SITE ROAD
NOISE BUFFER FENCE
OFF SITE SURFACE RUNOFF HOLDING POND
EXCESS SOIL STOCKPILE AREA (1 ACRES)
18" SD TO BE ABANDONED
20+00
10+00
0+00
50+00
40+00
30+00
20+00
10+00
0+00
STREAM MONITORING STATION (6 PLACES)
LEACHATE TREATMENT FACILITY
CLEANOUT FOR 8" LEACHATE COLLECTION SYSTEM
PERMANENT SITE ROAD
ON SITE SURFACE RUNOFF DRAINAGE CHANNEL
OFF SITE SURFACE RUNOFF DIVERSION CHANNEL
GROUNDWATER MONITORING STATION (8 PLACES)
LEGEND
0
100
200
400
600
800
GRAPHIC SCALE

R.T.T.
R.E.C
R.V.H
AS SHOWN
JULY 75
73-5-406.032

Stevens, Thompson & Runyan, Inc.
Engineers / Planners

SNOHOMISH COUNTY
CATHCART SANITARY LANDFILL

PHASE III
BASE SITE FOR FUTURE USE

21/21

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Cathcart Sanitary Landfill

Design Report
Volume II

Snohomish County
Public Works Department

Stevens, Thompson & Runyan, Inc.

SOLID WASTE DISPOSAL SYSTEM

SNOHOMISH COUNTY

CATHCART LANDFILL

DESIGN REPORT

VOLUME II - APPENDICES

AUGUST, 1975

Stevens, Thompson & Runyan, Inc.
Engineers / Planners
PORTLAND · SEATTLE · BOISE · SPOKANE

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APPENDIX A

FACILITY & OPERATIONAL PLAN DESIGN

PHASE 1 - REPORT NO. 2

This appendix includes excerpts from the Phase 1 - Report No. 2 which was a preliminary report to Snohomish County from Stevens, Thompson & Runyan, Inc. concerning an early evalution of the Wintermutes and Cathcart sites as potential sanitary landfill sites. The appendix contains general landfill requirements, alternative approaches for meeting the requirements and a description of the Cathcart site.

The information taken from the preliminary report supplements the final design report, except where quantities have been substantially revised in final design. These quantities are noted in this Appendix.

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SYSTEM REQUIREMENTS

CELL DIMENSIONS

The design of the daily cell development in the sanitary landfill is one of the most important design considerations of the facility. The cell development must be designed in such a way as to assure that the following criteria are met:

1. Unrestricted access is provided to the sanitary landfill working face by the vehicles depositing waste at the site.
2. The working face is kept as small as is practical to satisfy environmental and aesthic considerations.
3. The slope of the landfill working face and the thickness of layers in which waste is applied to the working face are designed to assure maximum waste in compaction.
4. The working face slope and cell height are designed to assure the safety of the landfill operators.
5. The daily cover material usage rate is minimized.
6. Sufficient cover is provided to meet the health and aesthetic requirements of the sanitary landfill.

The cell development should also be designed to obtain cover for the fill operation through excavation on the site. Thus, when more than one cell lift is placed on the site, sufficient soils excavation must be made to provide for future cover requirements, since the cell layer will cover the source of materials. The determination of cover requirements and cell development is therefore important to assure proper design of fill development and cover excavation.

A typical daily cell development is presented in Figure 1 in order to define terminology. The working face length of the daily cell for the urban sanitary landfill must be a minimum of 110* feet in order to allow adequate access by the number of vehicles transporting waste to the site. The actual working face length would vary so that the cell thickness could be kept constant to control the landfill development. A working face slope of 3 to 1 should be maintained for minimum cover usage and maximum waste compaction. The cell would require a daily cover of 6 inches of compacted soil. A depth of 12 inches would be required for the top of the cell when it is to be left uncovered for more than 6 months.

A cell height of 9 feet with a lift height of 10 feet is recommended for operational ease and safety. However, a higher cell height would reduce cover usage rates. Using these

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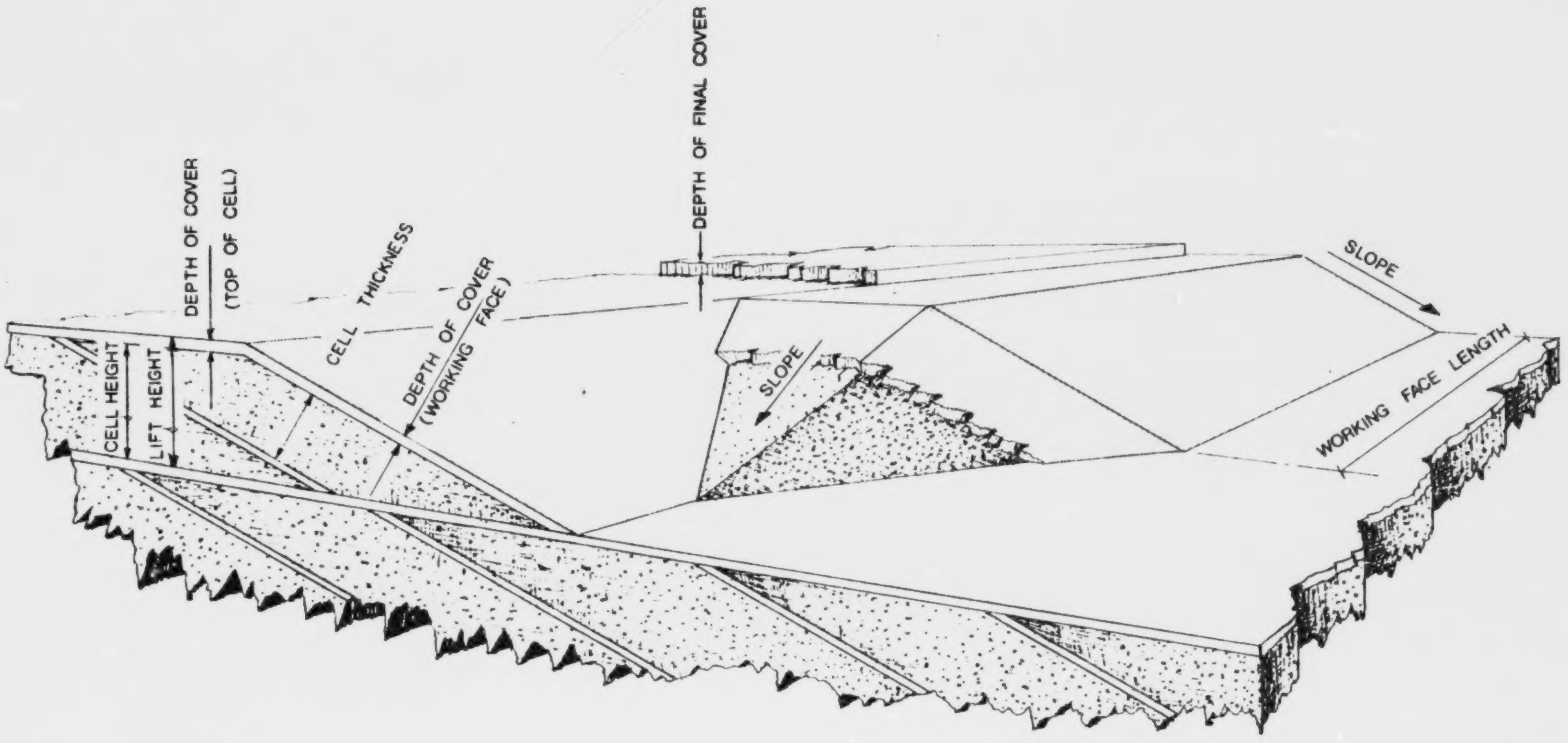
*Revised to 45 feet in final design.


DEPTH OF COVER
(TOP OF CELL)
CELL THICKNESS
DEPTH OF COVER
(WORKING FACE)
DEPTH OF FINAL COVER
SLOPE
SLOPE
WORKING FACE LENGTH
CELL HEIGHT
LIFT HEIGHT

·TYPICAL CELL DEVELOPMENT·
AREA METHOD SANITARY LANDFILL

FIGURE-1

cell dimensions, and assuming that it would require 1 1/2 cubic yards of excavated soil to obtain 1 cubic yard of compacted cover because of soil loss during the cover operation, the excavations required for daily cover for the urban sanitary landfill are tabulated in Table 3.

TABLE 3
DAILY COVER REQUIREMENTS

Year	Excavation Required for Daily Cover
1975	90,000 yd3
1980	95,000 yd3
1985	[illegible]
1990	10,000 yd3

REVISED

LITTER CONTROL

A potential problem associated with the operation of a sanitary landfill is the blowing of loose material from the working face. On windy days, the amount of loose material can be great and the litter can be blown off the site.

The normal method of litter control is the construction of fences as close to the working face area of the fill as possible. The fences are normally constructed of a fine mesh screen to allow air movement through the fence so that litter is less likely to be carried over the fence. The screen must be of mesh fine enough to trap the litter.

A strict site maintenance program is also required, whereby personnel continuously collect litter which is scattered on site and trapped by the fences. Specific manpower and equipment requirements for this operation will be dependent on weather conditions and the ability of the site operators to compact incoming refuse within the shortest possible time. Methods for collecting litter include hand pickup by site personnel and mechanical pickup by truck-mounted vacuum systems.

Initial costs for portable litter control fencing are approximately $15 per foot, with the total cost being $3,000 - $5,000*. Costs for a maintenance program for litter pickup and moving of portable fencing are dependent on the performance of site operations. A minimum program would include one individual with a small truck assigned periodically to site cleanup and maintenance, including some landscape and repair work. This program would result in costs of approximately $10,000 per year.

---

*Revised to under $3,000 for final design.

NOISE CONTROL

The noise produced by equipment operating a sanitary landfill and by vehicular traffic transporting waste to the site can present problems to individuals living near the facility. The noise levels associated with operating equipment which might be utilized at the site are presented in Table 4. These noise levels are for distances of 50 feet from the equipment. The actual noise levels attributed to site operations or refuse haul that would occur at any specific location near the landfill are a function of a number of variables. These variables include background noise levels already present at that location, the distance from the location to the landfill operation noise source, topography including trees and structures between the noise source and the location, and meteorological conditions at that time. It is therefore difficult to forecast specific impacts which may be generated by noise developed at a landfill. However, noise attenuation caused by peripheral barriers and ground absorption can be assumed to be over 40dB for distances greater than 500 feet from the operation. This attenuation combined with feasible noise controls placed on equipment should meet a desired noise level of below 40dB which will result in minimal impact to the surrounding areas, as shown in Table 5.

TABLE 4

EQUIPMENT NOISE LEVELS
in dB(A) at 50 Ft.

Equipment	Present Noise Level	With Feasible Noise Control1
Front loader	79	75
Backhoes	85	75
Dozers	80	75
Tractors	80	75
Scrapers	88	80
Graders	85	75
Truck	91	75

Source: "Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances" U.S. EPA, 1972

TABLE 5
ESTIMATES OF MAGNITUDES OF NOISE EFFECTS
[In dB(A)]

Effect	Moderate Level	Appreciable Level
Hearing Damage Risk	70	90
Speech Interference	45	60
Sleep Interference	40	70
Physiological Stress	*	90
Startle	*	110
Annoyance	40	60
Task Interference	55	75

ODOR AND GAS ATTENUATION

A problem associated with a poorly operated solid waste landfill is the presence of odors near the site. This problem is primarily caused by allowing air to be in contact with decaying garbage because of improper or inadequate soil covering. Thus, the daily compaction and covering of the waste are critical. Odor can be controlled only if the covering operations are continuously maintained.

In the sanitary landfill, organic waste is converted into inorganic materials, water, and gases through biodegradation. In the presence of oxygen, the biological activity is carried out by aerobic bacteria, and CO2 is the primary gas produced. After the available oxygen has been utilized by this process, which normally takes several months, the biodegradation is carried out by anaerobic bacteria. In the anaerobic process, CO2 methane, ammonia, hydrogen sulfide, nitrogen, and hydrogen gases are produced. The volume of gas produced is theoretically 15 cubic feet at atmospheric pressure per pound of volutile solids. Thus, in the landfill it can be assumed that 35 percent of the waste is originally reducable, the density is 1000 pounds per cubic yard, and the gas production potential over the life of the landfill is approximately 190 cubic feet of gas at atmospheric pressure per cubic foot of landfill space. While the potential gas production can require a number years to take place, gas production rates are significant and the gas produced can contain up to 50 percent methane.

The gas produced at the landfill can have several effects. If concentrated when vented to the atmosphere, odors can result. Since the methane and hydrogen portions of the gas are flamable, fires may occur either in the fill itself or at points where gas is concentrated when vented to the atmosphere. Cases have been recorded where gas has migrated horizontally for considerable distances in the subsurface soils and caused explosions in the basement of structures. The ammonia and CO_2 gases can dissolve in the moisture present in the fill. The CO_2 in part forms a weak acid (carbonic acid) in solution which will react with metals, especially iron, causing the metals to enter the solution. The CO_2 in solution also readily reacts with limestone, greatly increasing the $Ca\ CO_3$ hardness of the solution.

The control of gas generated at a sanitary landfill is important. This is especially true for a landfill at the proposed alternative locations in Snohomish County, since the silty-clay materials available for cover have a low permeability. This will tend to trap the gases in the cells and could create explosions, fires or horizontal movement of the gases from the site through subsurface soils. Control of the downward movement of gases is not critical, however, because of the low permeability of the subsurface silty-clays.

A system will be required for venting the gas produced in each individual cell. The venting can be accomplished with the use of a pipe collection network. The gas collected in the pipe may have to be burned prior to release to the atmosphere for odor control and prevention of any uncontrolled fire. The development of a pipe network would be difficult, however, because of possible interference with daily operations, especially in multi-lift landfill operations. Pipe network would also be difficult to maintain because of settlement in the landfill.

A more practical method of gas control would be the construction of a gravel-filled ditch in the top of each cell. This ditch would act as a gas vent because of the porous gravel. A ditch backfilled with gravel should also be constructed at the site perimeter to assure that gas did not migrate laterally from the site. This control system would then be monitored to assure that gas was venting properly. If it were found that gas were accumulating in the cells and not venting properly, a negative pressure pipe network could then be constructed to vent gas from the cells.

VECTOR CONTROL

The presence of health vectors including flies, rodents and seagulls is often associated with improperly operated solid waste disposal operations. The daily covering and compaction of the refuse with soil in a properly operated sanitary landfill does much to correct this potential problem. If the refuse is frequently covered, it is no longer a source of food or harborage for rodents. The soil cover, if well compacted, will prevent the emergence of flies from the refuse. A potential will exist for birds to feed from the refuse before it is covered with soil. This problem can be alleviated by keeping the working fact of the fill as small as possible.

A program should also be established for rat baiting on the site to assure that a rodent problem does not occur. This baiting program should result in costs of less than $100 per month.

WATER POLLUTION AND DRAINAGE CONTROL

In Report No. 1, the four types of ground and surface waters normally appearing at a sanitary landfill were described and discussed. These were:

1. Off-site surface runoff: Surface waters originating from precipation off the site and entering the site through overland flow.

2. On-site surface runoff: Surface waters originating from precipitation on the site.

3. Off-site groundwater: Ground waters entering the site through pervious soil strata and quite often appearing on the site as springs.

4. Leachate: On-site groundwater polluted by percolation through solid wastes.

The first three types of water are potential sources of leachate if not properly managed, and the volume of leachate to be treated depends greatly on the drainage control systems developed on the landfill site. Therefore, the attenuation of leachate starts with the diversion of off and on-site surface runoff and off-site groundwater in their unpolluted state.

The following is a discussion of specific design requirements and objectives for drainage control for the purpose of minimizing the volume of leachate.

Off-Site Surface Runoff

Off-site surface runoff may enter a landfill site in two forms: either continuously as a relatively large, discrete, flowing body of water (rivers, creeks), or intermittently, during and subsequent to precipitation, as indiscrete overland flow. Of these two forms of runoff, the latter is the most difficult to control.

Rivers and creeks of the magnitude affected by any landfill operation covered in this study can be controlled by the installation of impervious liners in the channel bottom and sides. This would prevent river or creek water from intruding the surrounding soil and becoming leachate as well as preventing leachate from polluting the river or creek.

Intermittent overland flow must be collected and transported to a body of receiving water. This would be accomplished by the construction of peripherial ditches intercepting any overland flow before it reaches the fill areas.

For sizing these ditches, the rational method will be used. This method gives a relationship between the size of the drainage area, characteristics of the drainage area, precipitation intensity and the resulting flow as expressed by the following equation:

$$Q = Ci\ A$$

Where

Q = flow in cubic feet per second

C = Dimensionless number ranging from 0 to 1 expressing surface characteristics of the drainage area

i = Rainstorm intensity in inches per hour

A = Drainage area in acres

To determine a design flow for which to size interceptor ditches, the following parameters will be used.

C = 0.2
i = .75 inches per hour

This will give a design peak hour flow of 0.15 cubic feet per second per acre of contributing drainage area.

These parameters and resulting flows will be refined when more knowledge of topography and surface characteristics of the contributing drainage areas are known.

On-Site Surface Runoff

On-site surface runoff will be similar to the intermittent overland flow as described under off-site surface runoff, and the same design criteria will be used, i.e. peripherial ditches and a design peak hour flow of 0.15 cubic feet per second per acre.

On-site surface runoff is generally relatively unpolluted. Experience has shown that BOD concentrations of these waters generally range from ten to twelve milligrams per liter (mg/L). The runoff usually contains a high concentration of inorganic solids due to erosion of cover materials. Occasionally, the runoff may also have a high concentration of coliform bacteria.

Based on these parameters, the installation of a settling basin for the removal of inorganic suspended solids is usually provided. Since there is some biological activity in such settling ponds that may have a removing effect on coliform bacteria, a monitoring program should be initiated to determine if a disinfection system is required.

To minimize the suspended solids concentrations in the on-site surface runoff, the completed parts of the landfill should immediately be seeded with grass.

Off-Site Groundwater

Off-site groundwater is the most difficult to control for the purpose of attenuation of leachate and general prevention of pollution. Because both flow directions and volumes vary greatly with the depths and permeabilities of soil strata, it is imperative that thorough soils investigations be performed before any systems are designed or constructed.

Four different methods may be employed to divert off-site groundwater:

1. Vertical impervious peripherial barriers diverting the groundwater in the ground itself.

2. Peripherial drain pipes intercepting the groundwater before it enters the landfill site.

3. Overexcavation of the off-site storm runoff ditches to also collect off-site groundwater in case the off-site groundwater is perched on a relatively shallow impervious soil stratum.

4. Drain pipes at or immediately below the ground surface where springs occur and an impervious barrier on top of these drain pipes preventing leachate from entering the spring drain pipes.

Vertical impervious barriers are used for groundwater control in several types of construction projects. However, in numerous cases, the groundwater tables have risen behind such barriers. This, in turn, has caused flooded basements and inoperative septic tank drainfields behind these barriers. Therefore, vertical, impervious peripherical barriers are not recommended unless it can be accurately predicted that no harmful effects result from a higher groundwater table behind the barriers.

In cases where shallow perched watertables are encountered, peripherial drain pipes removing the groundwater before it enters the landfill site would probably be the best solution. These pipes could drain into nearby receiving waters by gravity if the ground surface allows. Otherwise, the groundwater will have to be pumped.

The volumes of off-site groundwater that will be diverted cannot be estimated until the system is in operation. However, a rough estimate can be made when the permeability of the surrounding soils are known.

In cases where the off-site groundwater appears on the landfill site as springs and the depth at which it enters the site is too great to economically divert with peripherial drain pipes or overexcavated off-site runoff ditches, the most feasible method will be to divert the springs where they appear on the site.

This kind of situation usually occurs in ravines and the collection and transportation of springs can usually be done entirely by gravity.

Although some measurements of spring flows can be made before a collection system is designed and constructed, reliable flow data cannot be obtained until after the system is placed in operation.

Leachate

The proposed methods of landfill operations and the drainage improvemetns are all designed to minimize and possibly eliminate the generation of leachate. However, in case a problem occurs, a standby system for the collection and treatment of leachate is recommended.

The only practical method of collecting leachate is by the means of drain pipes at those parts of the periphery where detailed on-site groundwater studies have shown that leachate may be expected to occur. These drain pipes will be perforated and placed in a trench backfilled with gravel. The invert of the leachate collection pipe will be placed approximately at the same elevation as the lowest depth at which leachate contamination is likely to occur.

The leachate collection system would convey the leachate to a leachate treatment and disposal facility.

Table 6 lists characteristics of leachate reported for sanitary landfills throughout the country. As can be seen, a wide spread of concentrations of the different pollutants can be anticipated.

For the purpose of this study, a Biochemical Oxygen Demand (BOD) of 2,000 milligrams per liter (mg/L) is assumed for the purpose of estimating costs.

Four types of systems are considered feasible for the treatment and disposal of leachate. These include 1) teriary treatment and disposal to a local creek, 2) secondary treatment and disposal to a river, 3) intermediate (somewhat less than secondary) treatment and spray irrigation of the effluent on the completed, seeded parts of the landfill, and 4) disposal to a municipal sanitary sewerage system.

A tertiary leachate treatment facility has recently been installed at the Hidden Valley Sanitary Landfill, Bucks County, Pennsylvania. This facility consists of physical-chemical treatment process units that have proven themselves to provide a high quality effluent through numerous pilot plant studies, and the same treatment processes are recommended for Snohomish County if the discharge of the treated leachate to a local creek is required.

In case the discharge of the treated leachate to a stream with a relatively high flow (river) is feasible, a secondary biological treatment process will probably be the most feasible alternative.

TABLE 6

TYPICAL LEACHATE CHARACTERISTICS

PARAMETER	CEDAR HILLS F–C–R (1)	KENT–HIGHLANDS F–C–R (1)	KENT HIGHLANDS MILLER (2)	CALIFORNIA (3)	FUNGAROLI (4)
ph	5.8-6.2	6.0-6.9	6.3-6.5	6.0-6.5	3.7-8.5
Dissolved Oxygen	0-0.1	0-2.1	0		
Total Coliform-MPN	23-1600	8- 2400	7000-17,500		
BOD	1150-7000	820-7,300	1010-2240	21,700-30,300	
COD	1760-8870	1240-8,940	1250-3095		800-50,700
Total Solids			916-2045		
Suspended Solids			48-311		13-26,500
Volatile Solids			341-1103		
Alkalinity (CaCO3)			548-1571	730-9,500	
Total Hardness (CaCO3)			480-750	890-7,600	200-5500
Calcium			110-192	240-2,330	
Magnesium			214-333	64-410	
Total Nitrogen		31-447	26.4-124.0		
Organic Nitrogen			1.5-30.5	2.4-465	8-482
Ammonia - N			12.2-102.2	.22-480	2.1-177
Nitrate - N	0.9-2.4		.20-2.50		
Total Phosphate	0-0.1	0-20	.36-.72	.3-29	2-130
Ortho-Phosphate			0-.16		
Total Iron			27.7-143.8	6.5-220	.12-1,640
Sodium				85-1,700	127-3,800
Potassium				28-1,700	
Sulfate			16-35	84-730	20-450
Sulfide			2		
Chloride			0-65	96-2,350	47-2,340
Copper		0-0.026	2.4-3.6		0-7.6
Zinc		0-0.017			0.03-129
Nickel		0.1-0.6			0-0.81
Chromium		0-0.3			
Mercury		0-0.0004			
Lead	0.03-0.12	0.01-0.319	0		

NOTE: See following page for references, i.e., (1).

REFERENCE LIST

1. Food, Chemical, and Research Laboratories, Inc.

2. Miller, Joseph R., "Characteristics of a Sanitary Landfill Leachate and Its Treatability in an Aerated Lagoon," a Master's thesis, University of Washington, 1971. A study conducted at the City of Seattle's Kent Highlands landfill.

3. California State Water Pollution Control Board. Report on the investigation of leaching of a sanitary landfill. Publication No. 10. Sacramento, 1954.

4. "Pollution of Subsurface Water by Sanitary Landfills." United States Environmental Protection Agency, Solid Waste Management Research Grant EP-000162, Drexel University, Pennsylvania, (1971)

Although numerous pilot plant studies of biological leachate treatment have been performed, the only full scale biological leachate treatment facility in operation, as far as is known, is an aerated lagoon at the City of Seattle sanitary landfill at the Kent-Highlands. This lagoon has not performed adequately, probably because of unanticipated increases in flows and a lack of nutrients.

However, efficiency studies have proven that the aerated lagoon can convert the dissolved pollutants generally present in leachate into a suspended state which in turn could be removed by conventional solids removal facilities (i.e., clarifiers, sand filters, etc.)

Since the characteristics of leachate vary from landfill to landfill, it is recommended that, if this alternative is selected, the aerated lagoon be constructed first. While the lagoon is in operation, an extensive monitoring program would determine the type of solids removal facilities to be employed to further treat the aerated lagoon effluent. In addition, disinfection facilities will be required.

In case the distance to any receiving water or municipal sewerage system is large enough to cause economic difficulties, the alternative of intermediate treatment and land disposal on the completed, seeded parts of the landfill should be considered.

The treatment facility would consist of an aerated lagoon discharging into a combined polishing/storage lagoon. The dual purpose of this system would be to settle out the solids and to provide storage during rainy days. Based on rainfall records from the Everett-Monroe area, the polishing/storage lagoon should have a detention time of approximately 30 days.

Research on land disposal of wastes has shown that if a waste is allowed to flow overland for a distance of a few 100 feet, relatively good treatment may be accomplished.

The treated leachate will, therefore, appear as on-site surface runoff, be further treated while flowing overland, be collected with other on-site surface runoff by the on-site surface runoff collection ditch, and be further treated on the on-site surface runoff settling pond before being discharged to the receiving water.

Operation of the sprinkler facilities during days with rainfall is not recommended.

The alternative of pumping the leachate to a municiapl sewerage system would be selected if such a system is located in the vicinity of the landfill. In this case, final agreements would have to be made with the municipality regarding acceptance, pre-treatment requirements, and user charges.

Water Quality Monitoring

It is imperative that a water quality monitoring program of surface waters as well as ground water be undertaken approximately 12 months prior to initiation of landfill operations. The monitoring program should not be completed until it can be positively proven that the landfill has stabilized.

BUFFER AND RESERVED AREAS

Ten acres in the southeast corner of the site have been designated a reserve area, as it contains the only residence and building presently located on the site. Retention of the on-site residence and the 10-acre reserve (660 feet by 660 feet) would provide an excellent buffer between the site and the residences overlooking the site.

The site buffer should screen the landfill from view, block access to the area and attenuate noise generated on the site. The buffer area would be left in a natural state and be provided with additional plantings of evergreen trees and shrubs. In this way, the site would blend in with the surrounding area and a natural screen would be present throughout the year. A fence would be constructed in the buffer adjacent to the landfill area to prevent access by animals and unauthorized individuals, also blocking any litter generated during high wind periods. Soils excavated for future cover could be stockpiled to provide additional noise attenuation.

CATHCART SITE
SITE DESCRIPTION AND LOCATIONAL CONSIDERATION

SITE LOCATION

The Cathcart Site is being considered to serve the urban landfill service area and the South County rural landfill service area. It is located along the Woodinville Cutoff Road (State Highway 9) approximately 3 1/2 miles south of the town of Snohomish. The general location is shown on Figure 2.

GENERAL DESCRIPTION

The Cathcart site is approximately 160* acres in size, most of which lies in a moderately sloping gully between two ridges. The southeastern 40 acre portion of the site slopes moderately from a ridge down to Highway 9. The surface water drainage in the gully is intermittent.

The western 120** acre portion of the site is completely undeveloped. The southern 40 acres has been recently logged and is covered with young alder, stump and considerable slash. The remaining portion of the western 120** acres has a dense cover of second growth fir and alder trees.

The eastern 40 acres contains only a few trees and light brush. A house and three outbuildings are also located on this portion of the site.

The entire site is owned by the State of Washington Department of Natural Resources.

ZONING AND LAND USE

The Cathcart Site is located in a predominantly rural area. Several houses and small farms are located south and east of the site along 152nd Street east and along Highway 9 as shown in Figure 3. The north and west sides of the site have no residences or roads for a considerable distance.

At least one and possibly three residences are located immediately adjacent to the south property line near Highway 9 and overlook the eastern portion of the site. Other residences south of the site are located over 700 feet from the site and are separated from the site by a dense stand of trees.

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*Revised to 200 acres in final design.
**Revised to 160 acres in final design.

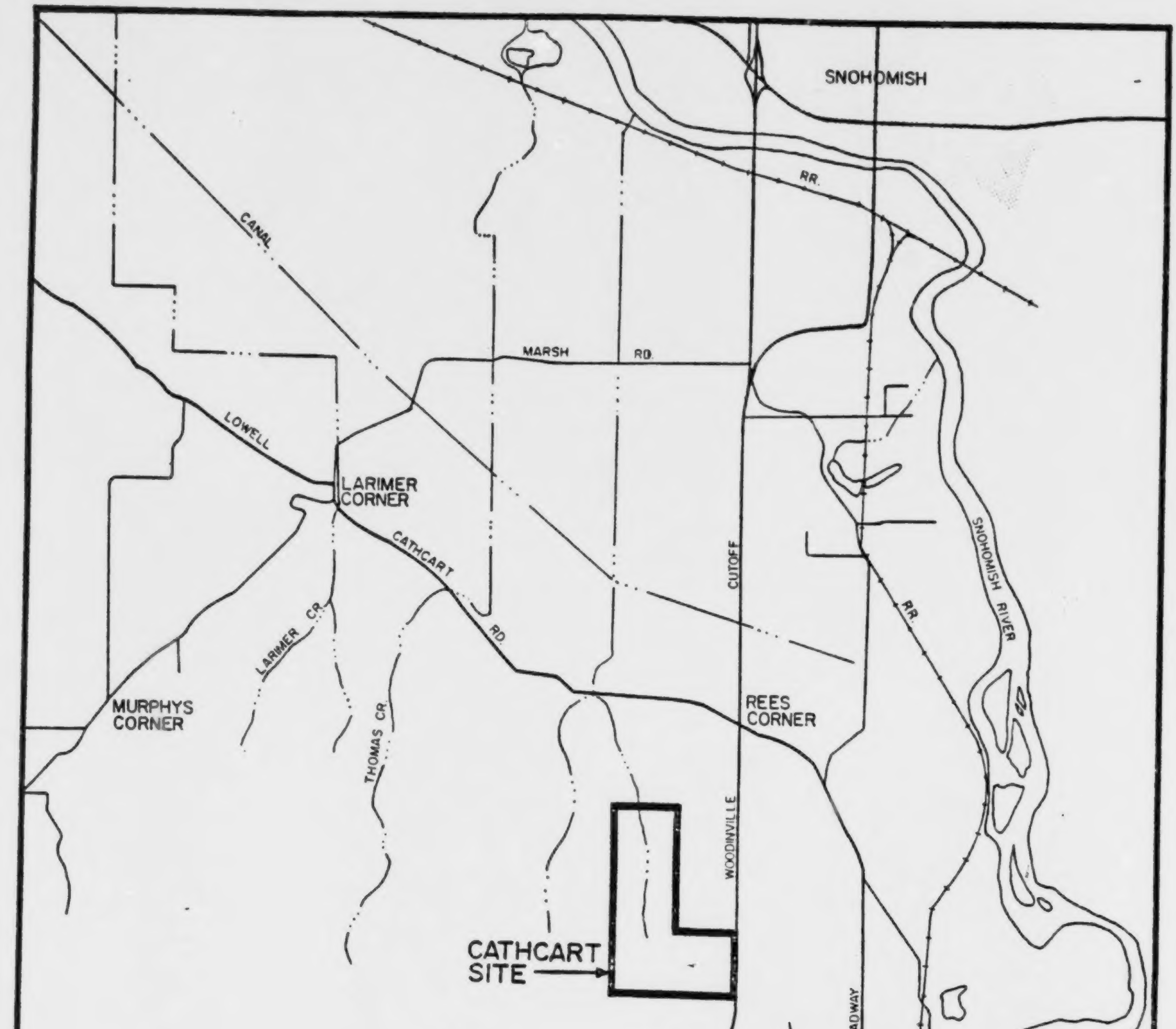
SNOHOMISH
RR.
CANAL
MARSH RD.
LOWELL
LARIMER CORNER
CATHCART RD.
LARIMER CR.
THOMAS CR.
CUTOFF
MURPHYS CORNER
REES CORNER
SNOHOMISH RIVER
RR.
WOODINVILLE
CATHCART SITE
BROADWAY
152 ND E.
VIRGINIA ST.
UNION ST.
CATHCART
VINE ST.
N
SCALE IN FEET
1000 0 1000 2000 3000

FIGURE 2

CATHCART DISPOSAL
SITE LOCATION

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Engineers / Planners

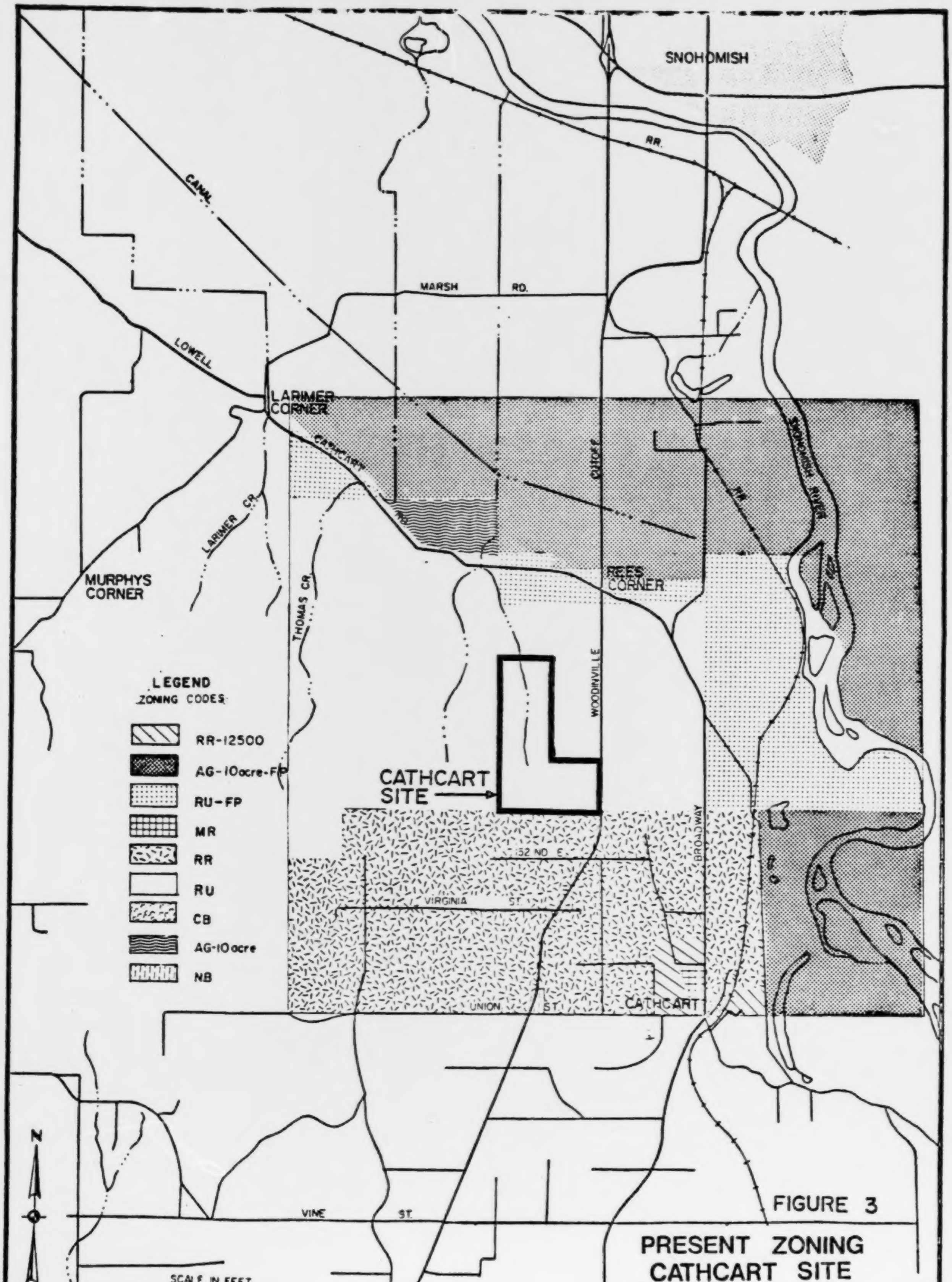

SNOHOMISH
RR.
CANAL
MARSH RD.
LOWELL
LARIMER CORNER
CATHCART RD
LARIMER CR.
MURPHYS CORNER
THOMAS CR.
RR
SNOHOMISH RIVER
REES CORNER
WOODINVILLE
BROADWAY
CATHCART SITE
152 ND E
VIRGINIA ST
UNION ST
CATHCART
VINE ST.
N
LEGEND
ZONING CODES
▨ RR-12500
■ AG-10acre-FP
░ RU-FP
▦ MR
▒ RR
☐ RU
▒ CB
▤ AG-10acre
▥ NB
SCALE IN FEET
1000 0 1000 2000 3000

FIGURE 3

PRESENT ZONING CATHCART SITE

Stevens, Thompson & Runyan, Inc.
Engineers / Planners
PORTLAND SEATTLE BOISE SPOKANE

Properties to the east of the site include residences along both sides of Highway 9. The houses between the site and Highway 9 are located over 700 feet from the site and are separated from the site by a densely wooded ridge. Residences along the east side of Highway 9 are downhill of the site. However, the eastern 40 acre portion of the site may be visible from some of the residences.

Properties to the north of the site have residences along the Lowell-Cathcart Road. The residences are at least 2,000 feet from the site[*] and are separated from the site[*] by dense woods and an elevation drop of approximately 160 feet. Surface water drainage from the 120[**] acre portion of the site flows to these properties.

Properties to the west of the site are completely undeveloped (no roads or houses) for at least one mile. The area is heavily wooded.

The present landuse zoning in the vicinity of the Cathcart site is shown on Figure 3. As can be seen from Figure 3, the site is presently zoned for rural use (RU). Under this zoning classification, sanitary landfill operations are permitted only upon issuance of a conditional use permit, in accordance with Section 18.18.030 of the Snohomish County Zoning Resolution.

SITE ACCESS

Major access to the Cathcart site is provided by State Highway 9 along the eastern 40 acre portion of the site. Access to the southern end of the site is possible from State Highway 9 along the paved 152nd Street East to an unimproved road which leads to the southeast corner of the site. The speed limit on Highway 9 is 60[+] miles per hour. The speed limit on 152nd St. E. is 35 miles per hour.

State Highway 9 provides direct access to the disposal site from portions of the service area located north and south of the site. Service areas to the east and particularly to the west, would probably use less direct routes travelling through the City of Snohomish via Highway 9, Lowell-Cathcart Road, Vine Street, and Maltby Road.

AVAILABILITY OF UTILITIES

The Cathcart Site is served by water, fire hydrants, power and telephone which are present along State Highway 9. Thus, the site has good access to these utilities.

[*] Revised to waste disposal area for final design.

[**] Revised to 160 acres in final design.

[+] Speed limit is now 55 m.p.h.

SOILS AND GEOLOGY

Subsurface Characteritics

The Cathcart site appears to have two basic soil types overlying a sandstone bedrock. The moderately hard sandstone, lying below the eastern ridge is fairly shallow, and apparently slopes downwards to the west. Glacial till caps the high ground on both sides of the gully. This material is a medium dense to dense mixture of sands, silts and some gravels. Saturated sands were encountered within the gully overlying the impervious glacial till. This material is a loose mixture of gravels, silts and mostly sands.

The dense glacial till, the loose sands and the weathered sandstone contain a relatively large percentage of fines. Preliminary soil analysis indicated that the glacial till contaminates about 45 percent fines, the loose sands contains 20 to 30 percent fines, and the weathered sandstone contains approximately 18 percent fines.

Water was encountered in the sands along the gully bottom and in an isolated pond near the top of the west ridge.

General Effect Upon Site Utilization

Additional soils investigations are necessary to supplement limited information describing subsurface characteristics, especially in the areas of bedrock location and slope, glacial till-bedrock contact, permeability of bedrock and surface soils, and groundwater flow. However, the present information allows some general observations on the Cathcart Site.

The glacial till materials should serve as suitable cover materials during dry weather. The till also contains sufficient fine materials so that, if it were used as cover material, the fill would prevent surface runoff from penetrating into the fill and become leachate. Excavation will require heavy equipment. The sands also contain considerable fines and should be suitable cover material. However, they would be a less efficient barrier to water movement than glacial till.

The sandstone bedrock may be an excellent leachate barrier depending upon its location, slope, and permeability. The sandstone may limit the depth of excavation in some areas of the site and may eventually limit the life of the site due to lack of on-site cover material.

The abundance of fines in all of the soils indicates difficulty in using the soils for cover and roads during wet weather. On-site dry soils could be stockpiled for use as wet weather cover. Other soils or materials may be needed for road surfaces during wet weather.

HYDROLOGY AND DRAINAGE

Surface Runoff

The majority of the Cathcart site is located in a draw draining northward. A small creek with seasonal flow runs northerly in the bottom of the draw. This creek has a drainage area of approximately 380 acres before it enters the site and peak flows of 57 cubic feet per second can be anticipated.

Several drainage facilities have been constructed in conjunction with road construction. These drainage facilities are shown on Figure 4 and include a 24-inch diameter culvert under Virginia Street and an 18-inch and a 24-inch under 152nd Street.

The creek draining through the site eventually enters the flat Snohomish River Valley through a 30 inch by 42 inch box culvert under Bluff Road.

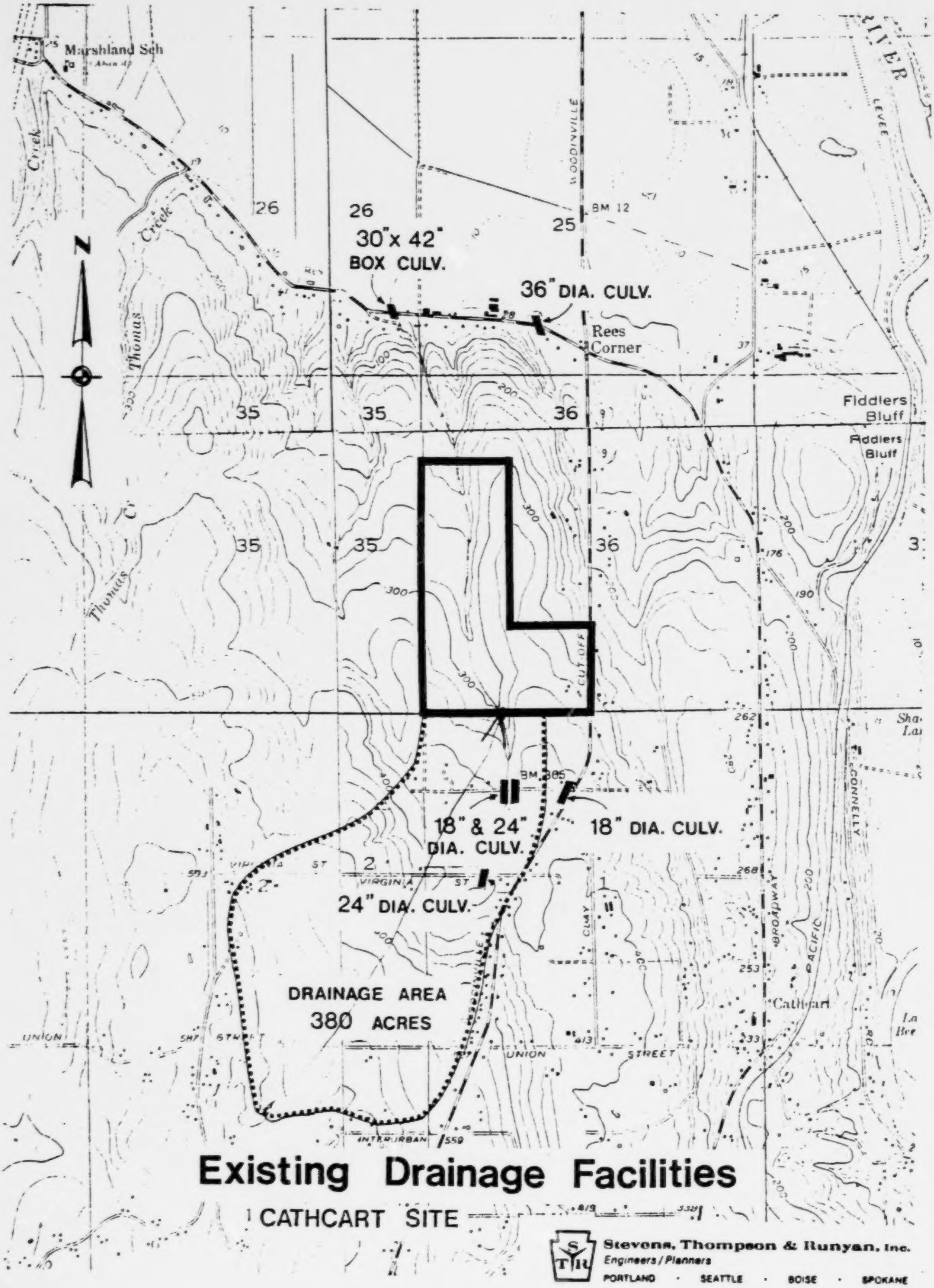
Groundwater

Very little information is available on groundwater movements. Preliminary soils investigations indicate that groundwater generally moves in the same direction as surface waters. The location of certain soil strata indicates that groundwater movements may also take place in a westerly direction. This must be investigated further before a definite conclusion can be made.

General Effect Upon Site Utilization

The major problem appears to be diversion of the seasonal creek flowing through the site. Because of the topography of the site, this creek will have to be partly diverted.

Another problem may be the disposal of treated leachate. The only body of water having any assimilative capacity is the Snohomish River which is located approximately 2 miles to the northeast. If the treated leachate were discharged to the seasonal creek, extremely advanced treatment equipment would be required to protect the water quality of this creek.


Marshland Sch
Creek
Thomas Creek
Thomas
26
26
25
BM 12
WOODINVILLE
RIVER
LEVEE
30"x 42" BOX CULV.
36" DIA. CULV.
Rees Corner
Fiddlers Bluff
Fiddlers Bluff
35
35
36
35
35
36
100
200
300
300
300
200
190
176
CUT OFF
BM 385
18" & 24" DIA. CULV.
18" DIA. CULV.
24" DIA. CULV.
VIRGINIA ST
2
1
262
268
253
233
CLAY
BROADWAY
PACIFIC
CONNELLY
Cathcart
DRAINAGE AREA
380 ACRES
UNION STREET
UNION STREET
INTERURBAN
559

Existing Drainage Facilities

CATHCART SITE

Stevens, Thompson & Runyan, Inc.
Engineers/Planners
PORTLAND · SEATTLE · BOISE · SPOKANE

FIGURE 4

APPENDIX B

WATER QUALITY MONITORING DATA

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MEMORANDUM
April 3, 1974

State of
Washington
Department
of Ecology

TO: Robert McCormick, Stewart Messman, Robert Aggas, Files

FROM: John H. Glynn

SUBJECT: PROPOSED CATHCART SANITARY LANDFILL,
SNOHOMISH COUNTY

On March 28, 1974, Bob McCormick, Bob Aggas, and I visited the proposed Cathcart Sanitary Landfill with Byron Robertson of the Snohomish County Health District and John Heneghan of Geolabs to look at the site and take background surface water samples.

The site is owned by the Department of Natural Resources. It is a moderately sloped gully. Bogs were noted throughout the site. Much of the vegetation was typical of wet sites. Surface water samples were taken near borings # 1, 3, 5 and 7, and ground water levels were measured as noted below:

PIEZOMETER #	DEPTH TO WATER
1	5.5 ft.
2	5 ft.
3	2.5 ft.
4	2 ft.
5	5 ft.
6	11 ft.
7	5 ft.
8	3 ft.

In addition, on March 31, 1974, surface flows were measured in the creek near the indicated piezometer stations as noted below:

PIEZOMETER #	DISCHARGE
3	3.0 cfs
7	6.9 cfs

According to county estimates "peak flows of 57 cfs can be anticipated" in the creek. A preliminary facility plan proposes the following water pollution and drainage control:

1. Off-site Storm Runoff
    a. Peripheral diversion using 48" pipe.
    b. Impervious pipe through fill.

Northwest Regional Office, 15345 N.E. 36th Street, Redmond, Washington 98052
Telephone: (206) 885-1900

MEMORANDUM

Show to Solid Waste

CHECK
[✓ INFORMATION] ______
FOR ACTION ______
PERMIT ______
OTHER ______

State of Washington
Department of Ecology

TO: John H. Glynn, Files

FROM: Laurence Ashley LA

SUBJECT: CATHCART - SNOHOMISH COUNTY PROPOSED LANDFILL

DATE: May 7, 1974

Five surface water samples were delivered. The samples were collected on March 28, 1974, from various sites around the proposed landfill site at Cathcart in Snohomish County. The results are attached on the following page.

LA:js
6-7-74 dt

cc: Snohomish County Health Department

SNOHOMISH COUNTY
March 28, 1974

SAMPLE	Ph	TOC	Cl	SO_4	TS	TOTAL HARDNESS	Na	K	Mg	Ca	Fe	Mn	Cu	COD	Pb	Cd	Cr	Zn	$N-NH_3$	DIS-ORTHO P	$N-NO_3$ NO_2	(ohm cm) COND.	FTU TURB.	COLOR
		mg/l																						
B-1S	5.9	18	4	9	76	6	3.2	0.3	0.7	1.8	0.5	.01	.01	4.0	.2	.01	.01	.01	.02	0.01	.01	31	2	120
B-3S	6.5	8	5	8	66	10	3.0	1.0	1.5	2.6	0.1	.01	.01	0.8	.2	.01	.01	.01	.01	.01	2.2	55	1	4
B-5S	6.5	10	6	9	62	10	3.0	0.9	1.7	2.8	0.1	.01	0.01	0.4	.2	.01	.01	.01	.02	.01	1.9	50	1	8
B-7S	6.6	9	5	9	63	10	3.0	0.9	1.5	2.8	0.1	.01	.01	1.2	.2	.01	.01	.01	.01	.01	1.9	49	1	7
B-9S	NA	7	5	7	NA	NA	3.5	0.8	1.6	2.8	0.1	.01	.01	0.4	.2	.01	.01	.01	.01	.01	2.0	55	1	8

MEMORANDUM

CHECK
INFORMATON ____
FOR ACTION ____
PERMIT ____
OTHER ____

State of Washington
Department of Ecology

TO: [illegible] and Files

FROM: J[illegible]

SUBJECT: [illegible] SANITARY LANDFILL

DATE: April 1, 1974

On March [illegible], 1974, stream discharges were measured with a pigmy meter at the following locations:

	Discharge	Temperature
a. Stream adjacent to piezometer #3	.[illegible] m³/s ([illegible] cfs)	[illegible]°F
b. Stream adjacent to piezometer #7	.[illegible] m³/s ([illegible] cfs)	[illegible]°F

[illegible]

Reproduced from best available copy.

Daniel J. Evans, *Governor* John A. Biggs *Director* Olympia, Washington 98504 Telephone (206) 753-2800

MEMORANDUM

Sno. Co.
Solid Waste

CHECK
INFORMATON _____
FOR ACTION _____
PERMIT _____
OTHER _____

State of Washington
Department of Ecology

TO: John Glynn and Files

FROM: Laurence Ashley LA

SUBJECT: SNOHOMISH COUNTY CATHCARD LANDFILL SITE

DATE: May 20, 1974

Ten background surface and ground water samples taken on April 8, 1974 from various locations around the proposed Cathcard Landfill site were delivered to the laboratory for chemical and physical analyses. The samples were collected by the personnel of the Snohomich County Health Department.

The results:

See the attached data sheet.

LA:mk
5-20-74 dt

cc: Snohomish County Health Department

SNOHOMISH COUNTY
April 8, 1974
Collected By Snohomish County Health Department Personnel

SAMPLE #	pH	TOC	Cl	SO_4	TS	TNVS	TVS	$N-NO_2$	$N-NH_3$	$N-NO_3$	COD	COND.	TURB.	COLOR	Na	K	Ca	Mg
		mg/l									ohm cm	FTU			mg/l			
B-1-G	8.2	450	340	100	1938	1558	380	0.004	160.0	20.0	21	3150	10	100	440.0	114.0	12.0	11.0
B-1-S	7.3	24	31	3	NA	NA	NA	0.004	0.06	0.01	7.2	49	4	155	26.0	0.4	1.5	0.9
B-3-G	7.8	310	12	44	473	323	150	<.001	0.36	<.01	38	440	22	5	58.0	1.8	32.0	11.0
-S	6.7	11	25	11	NA	NA	NA	0.002	0.02	2.0	2.4	128	1	5	20.0	1.1	1.7	1.2
B-4-G	8.7	330	20	14	1734	1510	224	0.002	1.2	0.08	60	400	112	15	145.0	5.1	0.5	15.0
B-5-G	7.8	200	29	24	443	288	155	<.001	0.13	0.01	15	560	6	5	59.0	3.4	32.0	20.0
B-5-S	6.9	10	6	12	NA	NA	NA	0.002	0.03	1.6	4.4	60	<1	5	25.0	1.0	1.4	1.2
B-7-G	7.6	19	16	40	714	598	116	0.015	0.09	1.3	7	220	3	5	32.0	2.0	2.2	7.5
B-7-S	6.9	9	32	8	NA	NA	NA	0.002	0.03	1.6	3.2	157	1	5	23.0	1.0	1.4	1.2
OFF SITE S	7.5	8	24	12	140	90	50	0.003	0.03	1.8	<1	128	1	5	26.0	1.0	1.5	1.2

SAMPLE #	Pb	Cd	Cu	Fe	Zn	Cr	Mn
	mg/l						
B-1-G	<.05	<.01	0.19	1.4	0.06	<.01	0.52
B-1-S	<.05	<.01	0.05	0.5	0.02	<.01	0.02
B-3-G	<.05	<.01	.01	1.6	0.07	<.01	1.0
B-3-S	<.05	<.01	0.11	<.1	0.01	<.01	<.02
B-4-G	<.05	<.01	0.25	17.0	0.23	.10	0.66
B-5-G	0.10	<.01	1.90	1.5	0.49	<.01	4.0
B-5-S	<.05	<.01	0.05	<.1	0.01	<.01	<.02
B-7-G	<.05	<.01	0.31	3.2	0.15	<.01	0.44
B-7-S	<.05	<.01	0.07	<.1	0.04	<.01	<.02
OFF SITE S	<.05	<.01	0.06	<.1	0.01	<.01	<.02

MEMORANDUM

CHECK
INFORMATON ____
FOR ACTION ____
PERMIT ____
OTHER ____

State of Washington
Department of Ecology

TO: John Glynn, Files

FROM: Laurence Ashley LA

SUBJECT: PROPOSED CATHCART LANDFILL - SNOHOMISH COUNTY

File

Solid Waste

DATE: June 3, 1974

Water samples from various sites around the proposed Cathcart Landfill and the proposed Byrant Landfill were delivered to the laboratory for chemical and physical tests. The samples were collected by personnel at the Snohomish County Health Department on April 23, 1974. The samples are for background information. The results are on the attached page.

LA:js
6-3-74 dt

cc: Snohomish County Health Department

SNOHOMISH COUNTY
4-23-74

SAMPLE	pH	CONDUCTIVITY u mhos	COD	TOC	Cl	SO_4	TURBIDITY FTU	COLOR	mg/l $CaCO_3$ as HARDNESS	K	Na	Ca	Mg	Fe	Mn
			mg/l	mg/l	mg/l	mg/l				mg/l metals	mg/l metals	mg/l metals	mg/l metals	mg/l metals	mg/l metals
B-1-G	8.0	1430	21	70	460	55	12	160	78	65.0	180	10.0	5.1	0.9	0.50
B-1-S	5.5	33	4	20	13	4	1	160	32	0.1	3.0	1.6	0.7	0.7	0.02
B-3-G	6.8	310	38	80	16	35	21	5	136	1.6	40.0	32.0	7.0	1.5	0.81
B-3-S	7.2	58	1	5	14	8	<1	5	56	0.8	3.0	3.2	1.2	0.1	<.01
B-3-G(B)	7.1	155	4	10	18	8	30	2	395	2.2	6.1	8.0	7.0	2.9	0.20
B-4-G	8.0	335	58	90	16	13	24	25	24	3.5	95.0	7.0	6.0	16.0	0.40
B-4-G(B)	7.4	180	28	40	16	3	15	2	108	1.6	4.5	15.0	13.0	3.6	3.0
B-5-S	7.6	49	2	10	14	<1	<1	3	23	0.7	3.0	3.0	1.5	0.1	<.01
B-5-G	7.4	500	15	49	14	8	27	8	188	3.5	46.5	38.0	17.5	4.5	6.0
B-6-G	7.7	270	27	55	22	75	8	2	108	5.0	50.0	9.0	2.2	0.3	0.01
B-7-S	6.5	49	2	8	14	8	<1	5	27	0.8	3.0	3.0	1.5	<0.1	<.01
B-7-G	7.0	144	2	17	10	50	16	5	148	2.5	5.0	11.0	5.0	2.9	0.51
OFF SITE(S)	6.7	58	2	5	10	2	<1	5	28	0.8	3.5	3.2	1.6	<0.1	<.01

SNOHOMISH COUNTY
4-23-74
(continued)

SAMPLE	Cu	Zn	Pb	Cd	Cr	Ni
	mg/1 ---metals---					
B-1-G	0.25	0.12	< 0.1	<.01	<.01	<.1
B-1-S	< 0.01	0.01	< 0.1	<.01	<.01	<.1
B-3-G	0.06	0.10	< 0.1	<.01	<.01	<.1
B-3-S	< 0.01	<.01	< 0.1	<.01	<.01	<.1
B-3-G(B)	4.0	2.3	0.1	<.01	<.01	<.1
B-4-G	< 0.01	0.20	< 0.1	<.01	<.01	<.1
B-4-G(B)	0.23	0.37	< 0.1	<.01	<.01	<.1
B-5-S	0.05	0.01	< 0.1	<.01	<.01	<.1
B-5-G	0.65	0.37	< 0.1	<.01	<.01	<.1
B-6-G	0.40	0.47	< 0.1	<.01	<.01	<.1
B-7-S	< 0.01	<.01	< 0.1	<.01	<.01	<.1
B-7-G	0.20	0.13	< 0.1	<.01	<.01	<.1
OFF SITE(S)	< 0.01	<.01	< 0.1	<.01	<.01	<.1

State of Washington
Department of Ecology

MEMORANDUM
July 16, 1974

TO: John Glynn and Files

FROM: Laurence Ashley

SUBJECT: CATHCART, SNOHOMISH COUNTY'S PROPOSED LANDFILL SITE

Eight water samples from various points around the proposed landfill site called Cathcart, in Snohomish County, were collected and delivered June 5, 1974 tothe laboratory for chemical and physical analyses. The results of the analyses are attached.

The nutrient values for samples of April 23, 1974 and May 8, 1974 are listed below:

Samples for April 23, 1974 -

Sample #	NO_2-N mg/l	NO_3-N mg/l	O-PO_4-P mg/l
B-1-G (c)	ND	0.02	0.03
B-1-S (c)	0.08	12.0	4.2
B-3-S (c)	ND	0.32	0.03
B-3-G (c)	ND	0.46	0.04
B-3-G (B)	ND	0.26	0.05
B-4-G (B)	ND	0.28	0.05
B-4-G (C)	ND	0.22	0.03
B-5-S (C)	ND	0.34	0.04
B-5-G (C)	ND	0.34	0.03
B-6-G (C)	ND	0.18	0.03
B-7-G (C)	ND	0.22	0.06

Samples from May 8, 1974 -

Sample #	NO_2-N mg/l	NO_3-N mg/l	O-PO_4-P mg/l
B-1-G	ND	0.17	0.04
B-1-S	ND	0.20	0.03
B-3-G	ND	0.12	0.02
B-3-S	ND	0.40	0.20
B-4-G	0.02	4.70	3.0
B-5-G	ND	0.22	0.33
B-5-S	ND	0.10	0.28
B-6-G	ND	0.06	0.20
B-7-G	ND	0.15	0.16
B-7-S	ND	0.27	0.14
Offsite	ND	0.57	0.14

LA:sc

cc: Snohomish County Health Department

SNOHOMISH COUNTY
5-8-74

SAMPLE	pH	u mhos CONDUCTIVITY	FTU TURBIDITY	COLOR	HARDNESS mg/las $CaCo_3$	COD	TOC	Cl
B-1-G	8.0	940	12	30	56	19	116	26
B-1-S	5.7	34	2	190	24	6	55	1
B-3-S	6.5	52	1	2	20	3	28	1
B-3-G	7.2	350	30	1	96	29	180	1
B-4-G	8.1	320	33	25	16	53	230	1
B-5-S	6.6	49	1	3	20	8	24	1
B-5-G	7.1	490	24	15	228	11	85	1
B-6-G	7.2	266	9	1	40	34	160	2
B-7-S	6.7	48	<1	3	20	8	27	1
B-7-G	6.5	128	24	2	76	10	40	1
OFF SITE S	6.8	57	<1	1	16	8	27	1

SNOHOMISH COUNTY
5-8-74

ITY	FTU TURBIDITY	COLOR	HARDNESS mg/1as $CaCo_3$	COD	TOC	Cl^-	SO_4	Na	K	Ca	Mg	Cu	Pd
				mg/1									
	12	30	56	19	116	260	23	110.0	35.0	14.0	5.6	0.64	<.1
	2	190	24	6	55	14	<1	3.6	0.5	1.7	1.0	<.01	<.1
	1	2	20	3	28	18	8	3.7	1.0	3.2	1.3	<.01	<.1
	30	1	96	29	180	16	24	40.0	1.6	37.0	10.0	0.23	<.1
	33	25	16	53	230	18	10	90.0	3.4	0.7	7.0	0.50	<.1
	1	3	20	8	24	16	3	3.6	0.9	2.9	1.5	<.01	<.1
	24	15	228	11	85	12	1	43.0	3.8	60.0	13.0	0.68	<.1
	9	1	40	34	160	20	69	50.0	5.0	11.0	2.3	1.10	<.1
	<1	3	20	8	27	14	8	3.7	0.9	2.8	1.3	<.01	<.1
	24	2	76	10	40	14	36	5.8	2.6	12.0	6.0	1.05	<.1
	<1	1	16	8	27	12	9	4.2	1.1	3.2	1.5	<.01	<.1

CATHCART SITE
JUNE 5, 1974

							mg/l		
SAMPLE #	pH	COLOR	FTU TURBIDITY	HARDNESS mg/l as $CaCO_3$	MHOS CONDUCTIVITY	COD	TOC	Na	K
B-1-S	5.5	210	1	32	30	7	50	2.0	0.3
B-3-S	6.7	5	1	20	56	1	34	3.7	1.0
B-3-G	7.5	2	6	140	400	25	148	39	1.6
B-4-G	7.6	40	50	52	390	61	185	100	2.7
B-5-S	6.5	15	1	28	62	1	47	3.5	0.8
B-5-G	7.3	15	39	324	700	15	102	50	3.6
B-7-S	6.4	15	1	20	55	1	35	3.5	ND
OFFSITE	6.6	7	1	20	52	2	36	4.1	1.0

mg/l

SAMPLE #	Mg	Cu	Pb	Cr	Ca	Cd	Zn	Fe	Mn	Cl	SO_4
B-1-S	1.0	<.01	<.01	<.01	1.1	<.01	0.02	0.7	0.10	3	4
B-3-S	1.5	<.01	<.01	<.01	2.1	<.01	<.01	<.1	<.01	4	8
B-3-G	9.0	0.25	<.01	<.01	25	<.01	0.20	0.7	0.82	5	15
B-4-G	3.7	0.30	<.01	0.03	3.0	<.01	0.30	6.0	0.18	6	5
B-5-S	1.3	<.01	<.01	<0.01	1.8	<.01	0.02	0.2	<.01	3	8
B-5-G	26	2.0	<.01	<0.01	40	<.01	1.25	10.2	7.5	5	3
B-7-S	1.3	<.01	<.01	<0.01	1.8	<.01	<.01	<.1	<.01	3	8
OFFSITE	1.4	<.01	<.01	<0.01	2.0	<.01	<.01	<.1	<.01	3	5

JUNE 5, 1974

mg/l

SAMPLE #	TS	TVS	TDS	TSS	NO_2-N	O-PO_4-P	NO_3-N
B-1-S	72	63	68	14	0.06	0.20	ND
B-3-S	62	25	59	3	0.65	0.20	ND
B-3-G	276	98	233	43	0.06	0.20	ND
B-4-G	457	160	269	188	0.10	0.14	ND
B-5-S	54	20	46	8	0.28	0.18	ND
B-5-G	493	195	333	160	0.36	0.08	ND
B-7-S	56	22	51	5	0.33	0.18	ND
OFFSITE	61	25	55	6	0.62	0.16	ND

MEMORANDUM

CHECK
INFORMATON ____
FOR ACTION ____
PERMIT ____
OTHER ____

State of Washington
Department of Ecology

TO: John Glynn and Files

FROM: Laurence Ashley

SUBJECT: CATHCART, SNOHOMISH COUNTY
PROPOSED LANDFILL SITE

DATE: July 19, 1974

Nine water samples were collected from various points around the proposed landfill site called Cathcart in Snohomish County, on June 19, 1974.

The samples were delivered by the Snohomish County Health Department personnel. The samples were analyzed for chemical and physical components and the results are as follows:

LA:sc

SAMPLE #	pH	COLOR	TURBIDITY FTU	HARDNESS mg/l as $CaCO_3$	CONDUCTIVITY mhos	COD mg/l	TOC mg/l	Cl mg/l	SO_4 mg/l	Fe mg/l
B-1-S	7.1	220	1	64	31	8	65	2	5	1.5
B-1-G	6.5	7	43	10	400	9	74	43	3	3.0
B-3-S	7.1	4	1	36	52	1	48	3	2	<.1
B-3-G	6.3	2	36	156	290	27	160	4	16	3.7
B-4-G	7.1	35	53	66	280	57	220	7	14	7.5
B-5-S	7.2	7	<1	40	61	2	29	3	10	<.1
B-5-G	6.0	20	33	280	520	17	132	5	5	9.0
B-7-S	6.9	3	<1	26	45.	1	31	3	9	<.1
OFFSITE	6.9	3	<1	28	55	1	49	3	13	<.1

CHECK
INFORMATON ______
FOR ACTION ______
PERMIT ______
OTHER ______

State of Washington
Department of Ecology

TO: John Glynn and Files

FROM: Laurence Ashley

SUBJECT: CATHCART, SNOHOMISH COUNTY
PROPOSED LANDFILL SITE

DATE: July 19, 1974

SAMPLE #	Mn mg/l	Na mg/l	K mg/l	mg mg/l	Ca mg/l	NO_2-N mg/l	NO_3-N mg/l	O-PO_4-P mg/l	
B-1-S	0.20	1.0	0.1	1.1	1.5	ND	0.18	1.42	
B-1-G	0.70	58	9.0	5.0	11.	ND	0.14	0.12	
B-3-S	<.01	3.7	0.9	1.5	2.2	ND	0.04	0.04	
B-3-G	0.80	37	1.6	9.0	25	ND	0.13	0.34	
B-4-G	0.20	100	2.5	3.5	3.2	ND	0.13	0.02	
B-5-S	<.01	3.9	0.8	1.5	2.0	ND	0.08	0.02	
B-5-G	7.0	38	3.7	25	36	ND	0.22	0.02	
B-7-S	<.01	3.7	0.8	1.5	2.2	ND	1.05	0.02	
OFFSITE	<.01	4.9	1.0	1.7	2.4	ND	0.07	0.02	

SNOHOMISH COUNTY
CATHCART SITE
7-24-74

SAMPLE	pH	COLOR	TURBIDITY NTU	CONDUCTIVITY u homs	HARDNESS $MgCaCo_3/l$	COD mg/l	**COLOR**	**TURBIDITY NTU**
B-1-S	7.2	150	7	35	20	15	**150**	**7**
B-2-S	6.5	3	5	114	36	5	**3**	**5**
B-2-G	6.2	2	18	290	94	16	**2**	**18**
B-3-G	6.6	35	34	380	24	40	**35**	**34**
B-5-S	6.9	25	1	59	22	2	**25**	**1**
B-5-G	6.2	7	22	490	202	12	**7**	**22**
B-7-S	7.3	3	1	66	26	1	**3**	**1**
B-7-G	7.1	15	16	144	73	NA	**15**	**16**
OFFSITE	7.0	4	1	84	26	1	**4**	**1**

SNOHOMISH COUNTY
CATHCART SITE
7-24-74

CONDUCTIVITY u homs	HARDNESS MgCaCo$_3$/1	COD mg/1	CHLORIDES mg/1	SULFATES mg/1	NO$_3$-N	NO$_2$-N	OPO$_4$-P
						(mg/1)	
35	20	15	4	1	0.012	ND	0.04
114	36	5	7	5	0.068	ND	0.04
290	94	16	6	11	0.140	ND	ND
380	24	40	7	10	ND	ND	ND
59	22	2	5	5	ND	ND	0.02
490	202	12	7	2	ND	ND	ND
66	26	1	5	5	ND	ND	ND
144	73	NA	NA	NA	ND	ND	ND
84	26	1	6	9	ND	ND	ND

SNOHOMISH COUNTY
CATHCART SITE
7-24-74

SAMPLE	COPPER	MANGANESE	IRON	CADMIUM	ZINC	LEAD	CALCIUM	MAGNESIUM
	----------	----------	----------	----------	-Soluble	Concentrations	(mg/1) of	Metals--------
B-1-S	<0.01	0.19	1.7	<0.01	0.04	<0.1	1.8	1.3
B-2-S	0.01	1.00	1.2	<0.01	0.04	<0.1	7.5	2.7
B-2-G	0.16	0.69	0.20	<0.01	0.12	<0.1	27.3	8.0
B-3-G	0.33	0.18	3.8	<0.01	0.18	<0.1	3.2	2.4
B-5-S	0.01	0.02	0.06	<0.01	0.01	<0.1	2.8	1.8
B-5-G	0.40	8.00	5.0	<0.01	0.01	0.20	47.5	23.5
B-7-S	0.01	0.02	0.05	<0.01	0.01	0.20	2.6	1.7
B-7-G	3.60	1.02	2.3	<0.01	1.50	0.1	17.5	8.5
OFFSITE	0.01	0.02	0.05	<0.01	0.02	0.1	3.2	2.1

SNOHOMISH COUNTY
CATHCART SITE
7-24-74

SODIUM	POTSIUM	SODIUM	POTSIUM	CHROMIUM
1.0	0.7	1.0	0.7	<.01
5.4	2.1	5.4	2.1	<.01
25.0	1.6	25.0	1.6	<.01
93.5	2.2	93.5	2.2	<.01
4.7	0.9	4.7	0.9	<.01
46.5	4.0	46.5	4.0	<.01
4.5	1.2	4.5	1.2	<.01
6.4	2.8	6.4	2.8	<.01
5.5	1.3	5.5	1.3	<.01

LA/mk 9-24-74

SNOHOMISH COUNTY CATHCART SITE, 8-7-74

mg/l

SAMPLE	pH	Color	Turbidity NTU	Hardness mg as $CaCO_3$/l	Conductivity homs	COD	Cl	SO_4	NO_3-N	NO_2-N	NH_3-N	O-PO_4-P	
B-1-S	6.4	240	3	90	34	9	3	1	<0.01	NA	0.02	0.02	
B-1-G	6.0	20	185	84	29	7	37	8	0.01	NA	16.0	1.20	
B-3-S	6.7	3	21	130	300	12	6	8	0.19	NA	0.02	0.01	
B-4-G	6.4	15	64	46	330	42	6	5	0.04	NA	0.20	0.12	
B-5-G	6.3	25	55	350	700	20	6	2	<0.01	NA	0.17	<0.01	
B-6-G	6.7	60	50	71	280	37	9	6	0.02	NA	0.84	0.26	
B-7-S	6.0	2	<1	28	80	<1	6	3	NA	NA	NA	NA	
Offsite	6.0	1	<1	30	80	1	6	10	0.30	NA	0.02	0.01	

Soluble Concentrations (mg/l) of Metals

Sample	Copper	Managenese	Iron	Sodium	Magnesium	Calcium	Lead	Chromium	Zinc	Cadmium	Potassium	Aluminum	Nickel
B-1-S	0.36	0.17	2.3	0.6	1.9	3.5	<0.1	<0.01	0.25	<.01	0.1	<0.1	<0.1
B-1-G	1.40	1.10	25.0	60.0	16.0	30.5	0.1	0.03	0.58	<.01	10.8	20.0	0.1
B-3-S	0.16	0.67	1.6	36.0	10.0	37.0	<0.1	<0.01	0.10	<.01	1.8	<0.1	<0.1
B-4-G	0.44	0.11	3.5	90.0	2.8	7.5	<0.1	<0.01	0.25	<.01	2.4	3.0	<0.1
B-5-G	1.28	9.00	31.0	50.0	40.0	60.0	0.1	<0.01	0.80	<.01	2.0	1.0	<0.1
B-6-G	3.80	0.25	3.10	50.0	4.6	13.0	<0.1	<0.01	2.10	<.01	12.8	<0.1	<0.1
B-7-S	<0.01	<0.01	0.1	4.3	2,8	6.5	<0.1	<0.01	<0.01	<.01	1.1	<0.1	<0.1
Offsite	<0.01	<0.01	0.1	5.4	3.2	7.5	<0.1	<0.01	<0.01	<.01	1.2	<0.1	<0.1

MEMORANDUM
September 25, 1974

State of
Washington
Department
of Ecology

TO: John Glynn and Files

FROM: Laurence Ashley LA

SUBJECT: CATHCART - PORPOSED SNOHOMISH COUNTY LANDFILL SITE

Two background water samples from the proposed Snohomish County Landfill site called Cathcart were mailed to the laboratory August 23, 1974. The samples were collected by Snohomish County Health Personnel on August 21, 1974.

The results:

Parameter		B-I-S	Off-site
pH		5.7	6.7
Total Hardness as mg$CaCO_3$/l		55	40
Conductivity - µmhoms		43	92
COD (mg/l)		11	<1
Sulfate (mg/l)		<1	10
Chloride (mg/l)		4	7
Turbidity - NTU		6	1
Color		240	2
Ammonia (NH_3)	mg/l	0.08	0.05
Ortho-phosphate (0-PO_4)		0.01	0.01
Nitrate (NO_3)		0.03	0.46
Sodium		2.1	5.8
Potassium		0.7	1.5
Magnesium		1.7	2.8
Calcium		5.0	8.0
Manganese		0.14	0.05
Lead		<0.01	<0.01
Chromium		<0.01	<0.01
Zinc		<0.01	<0.01
Copper		<0.01	<0.01
Iron		2.0	0.05

LA:sc
9-25-74 dt

State of
ashington
epartment
f Ecology

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

WATER QUALITY LABORATORY

DATA SUMMARY

..L. Ashley...
COPIES TO:
....
....
LAB FILES.....

rce Snohomish Co. Cathcart Landfill

e Collected 11-9-74; 12-9-74; 1-7-75

Collected By Snohomish Co. Health D

Goal, Pro./Obj.

(Page 1 of 2)

No.	Station	Date Collected	Sulfates	Chlorides	$N\text{-}NO_3$	$N\text{-}NH_3$	T.S.	T.N.V.S.	T.V.S.	T.S.S.
-702	B-4-G	11-6-74	10.	6.	ND	6.2	375.	225.	150.	115.
703	B-7-S	11-6-74	10.	3.	ND	0.03	80.	42.	38.	INSUFF. SAMPLE
704	B-3-G	12-9	14.	2.	1.55	0.50	241.	162.	79.	11.
705	B-5-G	"	25.	4.	0.02	0.26	640.	378.	262.	120.
706	M-3	"	7.	3.	0.12	1.6	435.	346.	89.	583.*
707	OFFSITE	(no date)	8.	6.	0.39	0.04	86.	46.	40.	245.**
708	B-1-S	↓	24.	3.	0.05	0.03	119.	36.	83.	7.
709	B-3-G	↓	12.	3.	ND	1.6	560.	456.	104.	452.
710	B-3-S	↓	4.	5.	5.0	0.04	94.	41.	53.	0.
711	B-5-G	↓	(broke)	5.	0.13	0.03	837.	529.	308.	273.
712	B-5-S	↓	9	4.	4.00	0.05	96.	29.	67.	2.
713	B-7-G	↓	160.	1.	0.20	0.03	292.	218.	74.	69.

714	B-1-G	1-7-75	24.	3.	3.6	0.02	186.	146.	40.	38.
715	B-1-S	↓	17.	2.	0.33	0.02	69.	30.	39.	8.
716	B-3-G		9.	1.	0.02	0.15	233.	148.	85.	16.
717	B-3-S		6.	3.	5.30	0.02	82.	36.	46.	2.
718	B-4-G		31.	3.	0.04	6.5	340.	195.	145.	65.
719	B-5-G		290.	4.	0.02	0.56	816.	527.	289.	119.
720	B-5-S		8.	3.	5.30	0.03	73.	25.	48.	0.
721	B-6-G		16.	4.	0.20	11.	306.	170.	136.	94.
722	B-7-G		23.	1.	ND	0.04	106.	35.	71.	40.

No.	Station	Date Collected	Sulfates	Chlorides	N-NO3	N-NH3	T.S.	T.N.V.S.	T.V.S.	T.S.S.
5-723	B-7-S	1-7-75	9.	3.	4.20	0.03	81.	13.	68.	5.
724	M-1	↓	7.	9.	0.68	0.04	90.	53.	37.	120.
725	M-3		6.	3.	0.05	0.27	130.	80.	50.	10.
726	M-4		14.	6.	0.49	0.03	1,694	1,525	169.	3,128
727	O-1		22.	7.	0.05	0.33	152.	86.	66.	45.
728	O-2		10.	1.	0.35	0.03	110.	74.	36.	101.

: All results are in PPM unless otherwise specified. ND is "None Detected"

LARGE FLOATING MATERIAL

LARGE PARTICLES (UNABLE TO DUPLICATE REPRESENTATIVE SAMPLES)

Summary by Stephen D. Pell Date 4-4-75

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

WATER QUALITY LABORATORY

DATA SUMMARY

e CATHCART - SNOHOMISH CO.

Collected 2-27-75

Collected By SCHD

Goal, Pro./Obj.

o.	Station	IRON	Cl^-	Sp. Cond. (µmhos/cm)	T. HARDNESS (as $CaCO_3$)	C.O.D.	$SO_4^=$			
58	B-1-S •	0.2	1.	40.	8.	39.	16.			
59	B-1-G •	0.3	1.	160.	16.	7.	16.			
60	B-3-S •	<0.1	1.	63.	9.	7.	6.			
61	B-3-G •	0.3	<1.	300.	42.	43.	8.			
62	B-4G •	1.1	2.	470.	14.	229.	8.			
63	B-5-S •	<0.1	3.	84.	12.	7.	10.			
64	B-5-G •	7.0	2.	1,300.	260.	132.	240.			
65	B-6-G •	0.3	4.	360.	32.	282.	17.			
66	B-7-S •	<0.1	3.	86.	13.	7.	6.			
67	B-7-G •	1.0	<1.	300.	53.	57.	125.			
68	M-1 •	<0.1	3.	44.	8.	7.	<2.			
69	M-2 •	2.0	9.	118.	18.	21.	28.			
70	M-3 •	<0.1	2.	210.	39.	14.	6.			
71	M-4 •	2.4	1.	65.	10.	121.	12.			
72	B-9S ~~OFFSITE~~	<0.1	1.	51.	8.	7.	25.			

All results are in PPM unless otherwise specified. ND is "None Detected"

Summary by Stephen D. Roll Date 6-11-75

RANDUM

CHECK
INFORMATON_____
FOR ACTION_____
PERMIT_____
OTHER_____

State of Washington
Department of Ecology

TO: John Glynn, Files

FROM: Laurence Ashley

SUBJECT: CATHCART LANDFILL, SNOHOMISH COUNTY

DATE: June 30, 1975

Sample set for 4-2-75 remaining data listed below:

SAMPLE	CONDUCTANCE (uhmos/cm)@25°C	pH	TOTAL ORGANIC CARBON (mg/liter)
M-1	30	7.0	3
M-2	110	6.4	10
M03	170	6.7	8
M-4	50	6.7	6
B-1-S	30	6.4	12
B-1-6	130	6.7	8
B-3-S	70	7.3	3
B-3-G	320	6.9	11
B-4-G	320	7.6	38
B-5-S	70	6.6	3
B-5-G	990	6.9	33
B-7-S	65	6.5	3
B-7-G	170	6.3	11
B-9-S	75	6.4	4
B-6-G	280	7.2	41

LA:js
6-30-75 d5

Daniel J. Evans, *Governor* John A. Biggs, *Director* Olympia, Washington 98504 Telephone (206) 753-2800

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

WATER QUALITY LABORATORY

DATA SUMMARY

rce CATHCART-SNOHOMISH Co

Collected By S.C.H.D.

Date Collected 4-2-75

Goal, Pro./Obj.

Log No.	Station	Cl^-	T. HARDNESS (as $CaCO_3$)	C.O.D	$SO_4^=$					
751273	B-1-S.	1.	4.	50.	19.					
74	B-1-G.	<1.	11.	11.	11.					
75	B-3-S.	2.	11.	7.	<2.					
76	B-3-G.	2.	40.	39.	12.					
77	B-4-G.	4.	12.	200.	18.					
78	B-5-S.	2.	11.	7.	10.					
79	B-5-G.	3.	220.	121.	220.					
80	B-6-G.	4.	29.	242.	4.					
81	B-7-S.	2.	11.	7.	7.					
82	B-7-G.	1.	36.	144.	73.					
83	B-9-S.	2.	12.	7.	6.					
84	M-1.	3.	9.	7.	<2.					
85	M-2.	15.	16.	14.	23.					
86	M-3.	2.	39.	22.	5.					
87	M-4.	2.	11.	18.	8.					

ote: All results are in PPM unless otherwise specified. ND is "None Detected"

Summary by

Date 6-11-75

MEMORANDUM

CHECK
INFORMATON _____
FOR ACTION _____
PERMIT _____
OTHER _____

State of Washington
Department of Ecology

TO: John Glynn, Files

FROM: Laurence Ashley

SUBJECT: CATHCART LANDFILL SITE, SNOHOMISH COUNTY

DATE: July 24, 1975

Several water samples taken at the various points at the Cathcart site by Snohomish County Health Department personnel on 11-6-74, 12-9-74, and 1-7-75 were analyzed and the findings are as follows:

12-9-75
some results

SAMPLE #	pH	COND.	TURBIDITY NTU	TOC (mg/1)
M3	6.6	165	78	43
B-1-S	5.9	65	1	43
B-5-G	6.9	885	78	170
B-3-G	7.0	355	5	23
OFFSIDE	7.0	105	1	7
B-3-5	6.3	105	1	6
B-7-6	5.1	310	16	22
B-5-5	6.2	95	1	5
B-1-G	6.2	165	18	9
B-4-G	NA	410	80	112
B-7-S 11-6 SET	6.0	85	1	6
B-4-G 11-6 SET	7.5	390	35	127

1-7-75
SET

B-1- S	6.0	40	1
B-5-G	7.0	1030	180
M-1	6.6	46	15
B-1-G	6.4	150	25
B-6-G	6.8	305	18
0-2	7.0	60	20
0-1	6.5	180	30
B-3-S	6.5	90	1
B-5-5	6.5	80	1
B-3-G	7.1	305	15
M-4	6.5	80	1040
M-3	6.6	170	8
B-7-S	6.9	80	1
B-7-G	6.2	50	18
B-4-G	7.4	410	54

: Snohomish County Health Department

COLIFORM COUNT - DATA CHART

DATE	GROUND WATER B-1	B-3	B-4	B-5	B-6	B-7	SURFACE WATER B-1	B-3	B-5	B-7	OFF-SITE	(Date)
1 8 74	6,000	<100	<100	100	N.S.	<100	<100	510	<100	<100	<100	
1 23 74	34,000	300	400	8,800	400	1600	1,100	400	200	200	200	
8 74	18,000	100	500	1100	<1	600	1,600	200	100	100	100	
5 74	2 400	100	100	NO H2O	<100	NO H2O	900	1000	300	100	300	
19 74	2 300	<100	<100	300	NO H2O	NO H2O	300	13,000	100	100	<100	
7 24 74	DRY	DRY	<100	<100	DRY	TNTC	2,200	DRY	400	400	50	
7 74	1600	<100	<100	200	<100	200	1600	DRY	DRY	<100	<100	
1 6 74	DRY	200	30	<10	DRY	DRY	DRY	DRY	DRY	250	DRY	
7 10 74	30	40	200	100	DRY	1400	800	180	130	200	350	
-7-75	50	10	50	10	150	100	240	42	160	150	NOT TAKEN	1-7-75
-27-75	<10	10	<100	<100	40	300	30	750	110	30	60	2-27-75
-2-75	<10	<10	<10	<10	120	30	300	170	60	50	80	4-2-75
7-30-75	40/<10 F.C	<10/<10 FC	270/<10 FC	750/<10 FC	450/<10 FC	DRY	Dr.	800/160 FC	1140/60 FC	550/80 FC	640/110 FC	7-30-75

APPENDIX D

REE'S CORNER SANITARY LANDFILL SITE

W-1035 -62

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GEOLABS-WASHINGTON, Inc.

Foundation and Soils Engineering, Geology

12893 N.E. 15th Pl. • Bellevue, Washington 98005 • (206) GL 5-2018
502 So. 11th St. • Tacoma, Washington 98402 • (206) 272-8363
3416 Everett Avenue • Everett, Washington 98201 • (206) 259-0817

Telex 32-9424

October 15, 1973 W-1035-62

Stevens, Thompson & Runyan, Inc.
700 Plaza 600
Seattle, Washington 98101

Attention: Mr. Ron Owes

Subject: Ree's Corner Sanitary Landfill Site

Gentlemen:

Based upon our prelininary subsurface investigation, we have determined that the site is underlain by a dense, gray, silty Sand and Sand (Glacial Till) and at greater depth, a moderately hard, brown Sandstone. On the east edge of the site, adjacent to Highway 9, below an approximate elevation of 325, the sandstone is at shallow depth and the till is not present. To the west, the high ground on both sides of the draw are capped by sandy, glacial till. Within the draw, saturated sands were encountered overlying impervious till and possibly bedrock.

A large quantity of water was encountered in the sands along the stream bottom and in an isolated pond atop the high ground at the west side of the property.

DESIGN CONSIDERATIONS

1. General

The site appears to be well suited for use as a sanitary landfill. The majority of the site soils, however, do not appear to be acceptable for use in construction of haul roads during wet weather. Therefore, importation of some granular material may be necessary. The site soils and rock are moderately dense to very dense and may require the use of relatively heavy equipment (D-7 or D-8 Cat) for their excavation. The majority of the soils are relatively impervious and percolation of leachate into the groundwater table should not be a serious problem. As an exception to this, saturated

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permeable sands in the bottom of the draw, may permit loss of leachate downslope to the north, if the sands are not removed or provided with some sort of a seepage cutoff system.

2. Groundwater Conditions

Some groundwater was encountered in a depression atop the knoll near the southwest corner of the site, while considerable quantities occur along the drainage course through the center of the property. Along the drainageway, the water appeared to be perched atop the relatively impermeable sandstone or till. The material which is causing the water to remain atop the high ground was not reached during our exploration; however, we suspect that this impermeable stratum is either sandstone or glacial till. We anticipate, based upon experience at similar sites, that during wet weather considerable seepage will be encountered along the upper surface of the glacial till or sandstone. On the other hand, we do not anticipate that appreciable quantities of seepage will flow along the till - sandstone contact.

3. Groundwater and Leachate Control

The upper surface of the sandstone appears to be higher on the east side of the site than near the center (Cross Section, Plate 2). As a result, we believe that there is little chance of leachate loss toward Highway 9. Additionally, we do not expect leachate to migrate readily along the till - sandstone contact to the south or west. In those areas where we have exposed this type of surface, the till has been tightly bonded to the underlying material. At this particular site, however, we did not reach this contact with our relatively shallow backhoe pits.

4. Grading

Due to their density, the site soils below depths of roughly eight or ten feet may prove to be difficult to excavate, except with relatively heavy equipment (D-7 or D-8 Cat). The overlying materials, however, probably can be excavated with considerably lighter equipment. The excavated dense soil may contain numerous blocks or clods, especially if excavated during dry weather. These lumps would need to be broken down prior to or during placement for refuse cover. In the same manner, the sandstone will probably require breaking up with the earthmoving equipment, prior to use.

Due to their relatively fine grain, the on-site materials, soil or rock, may be difficult to compact during wet weather. Therefore, it may be necessary to import granular materials during the rainy season.

Permanent cut and fill slopes constructed with the on-site soils or sandstone should be designed with an angle of no more than 2H:1V. Additionally, drainage berms, benching and planting should be included wherever they would be appropriate.

5. Access Roads

During dry weather, service roads crossing the site should remain relatively stable with only minor amounts of grading, however, due to the presence of appreciable quantities of silt in the soils, roadway sprinkling for dust control may be necessary during dry weather. On the other hand, these same soils will become soft, rutted and unstable during wet weather. Therefore, it may be advisable to gravel the roads or use some sort of impervious seal coat surfacing.

6. Recommended Additional Studies

The site features of most critical importance are: A) The configuration and condition of the till - bedrock contact; B) the in situ permeability of the site soils; C) groundwater conditions; and, D) detailed stability analysis of the downstream face of the completed site.

A. Due to the thickness of till and other overburden materials, the surface of the sandstone appears to a large extent, to be beyond the reach of a backhoe. An evaluation of the condition of this surface, however, is considered necessary because of the possibility that permeable soils may be present between the glacial till and underlying sandstone.

B. In order to understand and anticipate what may happen to any leachate generated by the landfill, it would be necessary to know the permeability characteristics of the sandstone, overburden and the contact between these deposits. As in the case of the above mentioned bedrock - overburden study, this work should be performed as part of the final subsurface drilling program. These two programs should effectively locate and outline any zones of potential leakage. They should also provide alternate design criteria for controlling such leakage if it does present a problem.

C. Due to the exceptionally dry weather conditions experienced during the past year, groundwater information obtained during this initial study may be misleading. For this reason, it would be appropriate to re-evaluate the shallow groundwater conditions during the coming rainy season with a tractor mounted backhoe.

D. Due to the inherent instability of the refuse, the configuration of the downstream (north) face of the planned embankment should be evaluated. In this manner, appropriate safe slope angles can be established based upon a reasonable factor of safety and the strength characteristics of the various materials used.

It should be born in mind that any further subsurface investigations will require the use of a relatively larger dozer to carve access roads through the brush, young second growth timber and numerous stumps found on the site.

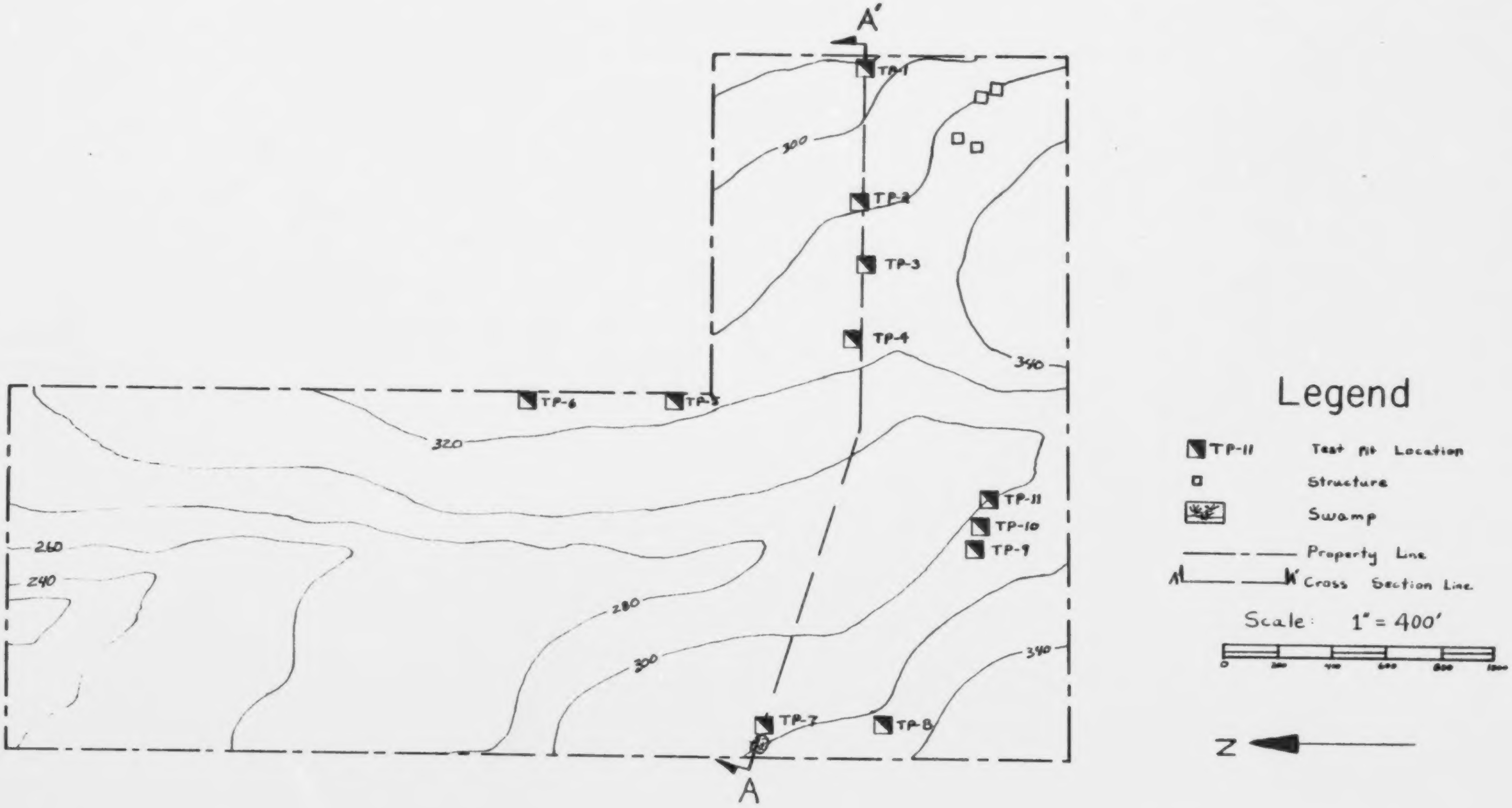
We appreciate having this opportunity to serve you. If you have any questions, please call.

Respectfully submitted,

GEOLABS-WASHINGTON, INC.

Tom Bekey, Engineering Geologist

TB/mh


A'
TP-1
TP-2
TP-3
TP-4
TP-5
TP-6
TP-7
TP-8
TP-9
TP-10
TP-11
A
300
340
320
260
240
280
300
340
Legend
TP-11 Test Pit Location
Structure
Swamp
Property Line
A A' Cross Section Line
Scale: 1" = 400'
0
200
400
600
800
1000
N

GEOLABS, INC.
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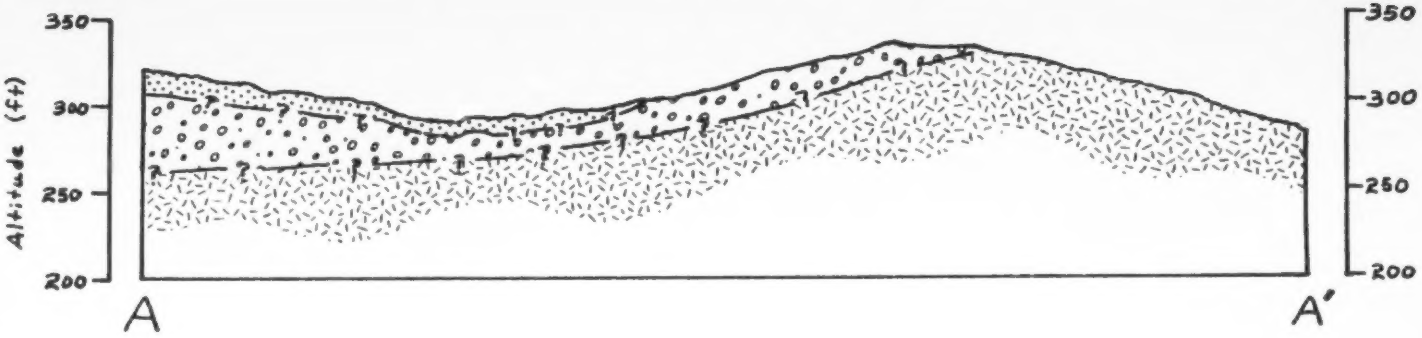
W.O. W-1085-62 DATE Oct. 1973
BY P.B. SCALE 1" = 400'

PLATE 1


350
300
250
200
Altitude (ft)
350
300
250
200
A
A'

▨ Water bearing Sands

▨ Glacial Till

▨ Bedrock

Scale: 1" = 400' Horizontal
1" = 100' Vertical

CROSS SECTION A-A'

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GEOLOGY AND SOIL ENGINEERING

DATE Oct. 1973 BY P.B.
SCALE — W.O. 1035-63

PLATE 2

APPENDIX A

EXPLORATION PROGRAM

SUBSURFACE INVESTIGATION

Our subsurface soils investigation for the Ree's Corner Sanitary Landfill Site was performed by excavating a series of backhoe test pits into the site soils at various locations on the site. Due to the very dense brush cover and numerous stumps, access during this study was restricted to the south, southwest, and east margins of the property. The materials encountered in the test pits were logged by our engineering geologist at the site. The approximate pit locations are shown on Plate 1, Site Plan. The material logs are presented in Table A. Laboratory test results of selected soil or rock samples are presented in Appendix B.

TABLE A

TEST PIT LOGS

Depth - ft.	Soil Classification
	Test Pit No. 1
0.0 - 0.5	Soft, moist, brown Topsoil.
0.5 - 2.0	Medium dense, moist, tan, silty Sand.
2.0 - 6.0	Dense to very dense, moist, brown Sand with angular rock fragments. (Weathered Sandstone) Refusal on moderately hard Sandstone. Dry hole.
	Test Pit No. 2
0.0 - 0.2	Soft, moist, brown Topsoil.
0.2 - 2.0	Medium dense, moist, tan, silty Sand.
2.0 - 4.0	Medium dense, moist, tan Sand with rock fragments.
4.0 - 9.0	Moderately hard, brown to gray Sandstone. Dry hole.
	Test Pit No. 3
0.0 - 0.5	Soft, moist, brown Topsoil.
0.5 - 2.5	Medium dense, moist, brown, silty Sand.
2.5 - 4.5	Medium dense, moist, brown, silty Sand with rock fragments.
4.5 - 8.0	Moderately hard, brown to gray Sandstone.
	Test Pit No. 4
0.0 - 0.5	Soft, moist, brown Topsoil.
0.5 - 4.0	Medium dense, moist, tan, silty Sand. (Weathered Till)
4.0 - 10.0	Dense, moist, gray, gravelly, silty Sand. (Glacial Till) Dry hole.
	Test Pit No. 5
0.0 - 1.0	Soft, moist, brown Topsoil.
1.0 - 3.0	Medium dense, moist, tan, silty Sand. (Weathered Till)
3.0 - 11.0	Dense, moist, gray, gravelly, silty Sand. (Glacial Till) Dry hole.

TEST PIT LOGS (CONT.)

Depth - ft.	Soil Classification
	Test Pit No. 6
0.0 - 0.5	Soft, moist, brown Topsoil.
0.5 - 5.0	Medium dense, moist, tan, silty Sand with rock fragments.
5.0 - 8.0	Dense, moist, gray-brown, silty Sand. (Glacial Till) Dry hole.
	Test Pit No. 7
0.0 - 1.0	Organic debris and logs.
1.0 - 3.5	Medium stiff, moist, gray Silt with organic debris. (Fill)
3.5 - 4.5	Stiff, moist, tan Clay with organic fragments.
4.5 - 5.0	Stiff, moist, gray Silt.
5.0 - 11.0	Medium dense, wet, gray, silty Sand with organic fragments. Water below five feet. Test pit is adjacent to swamp.
	Test Pit No. 8
0.0 - 0.7	Soft, moist, brown Topsoil.
0.7 - 5.0	Medium dense, moist, tan, gravelly, silty Sand with occasional cobbles.
5.0 - 6.5	Stiff, moist, gray Silt.
6.5 - 8.0	Dense, moist, gray, silty Sand. Dry hole.
	Test Pit No. 9
0.0 - 1.0	Soft, moist to wet, peaty Topsoil.
1.0 - 3.0	Medium dense, moist, gray-brown Sand with gravel.
3.0 - 6.0	Medium dense, moist, brown, silty Sand.
6.0 - 8.0	Loose, wet, gray, silty, gravelly Sand. Water below four feet.
	Test Pit No. 10
0.0 - 0.5	Soft, moist, brown Topsoil.
0.5 - 2.0	Medium dense, dry, tan, silty Sand with gravel.

TEST PIT LOGS (CONT.)

Depth - ft.	Soil Classification
	Test Pit No. 10 (continued)
2.0 - 3.5	Medium dense, moist, tan, gravelly Sand.
3.5 - 6.0	Medium dense, moist, red-brown to gray, fine Sand with gravel.
6.0 - 10.0	Dense, moist, gray, gravelly, silty Sand. (Glacial Till) Dry hole.
	Test Pit No. 11
0.0 - 1.0	Soft, moist, brown Topsoil.
1.0 - 4.0	Medium dense, moist, brown, silty Sand with roots.
4.0 - 7.0	Dense, moist, brown, gravelly Sand with occasional cobbles.
7.0 - 10.0	Medium dense, moist to wet, red-brown, gravelly Sand.
10.0 - 11.0	Dense, moist, blue-gray, silty Sand. Water between nine and ten feet.

APPENDIX B

LABORATORY TEST RESULTS

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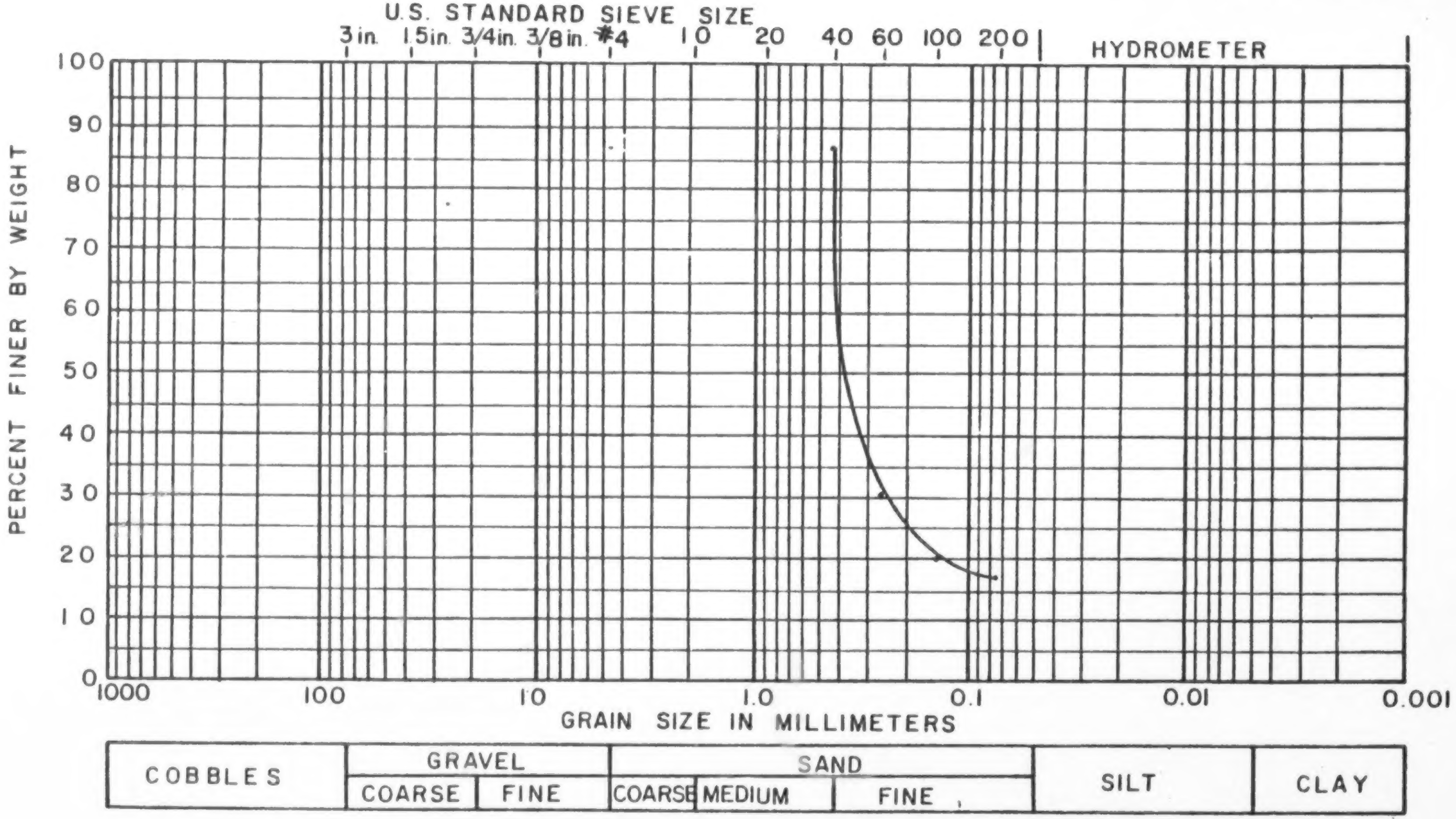
BORING NO. TP-1

DEPTH 6.0'

PROJECT Ree's Corner Landfill Site

W.O. 1035-62

PLATE B-1



GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING

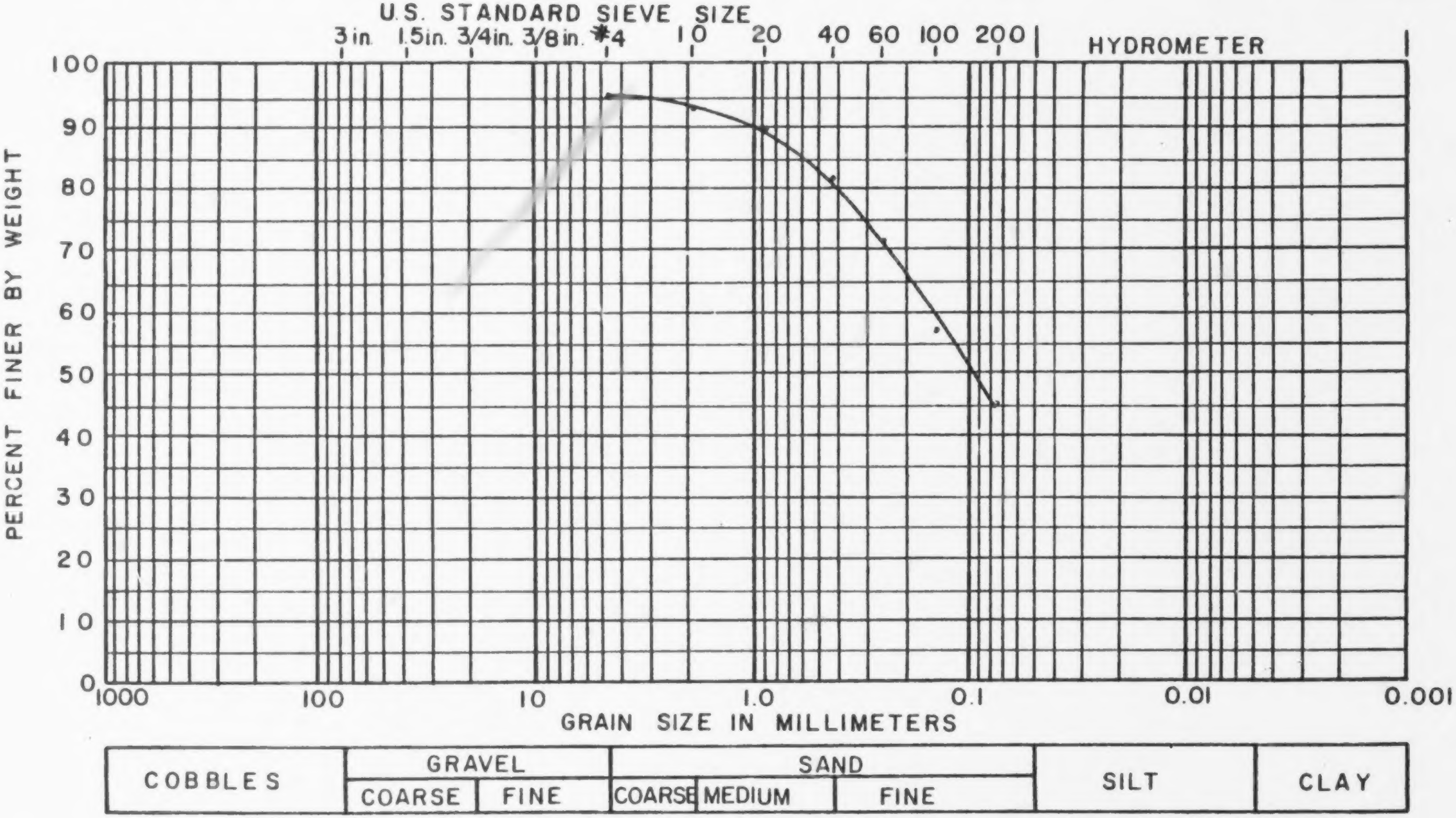
BORING NO. TP-4

DEPTH 9.0' - 10.0'

W.O. 1035-62

PROJECT Ree's Corner Landfill Site

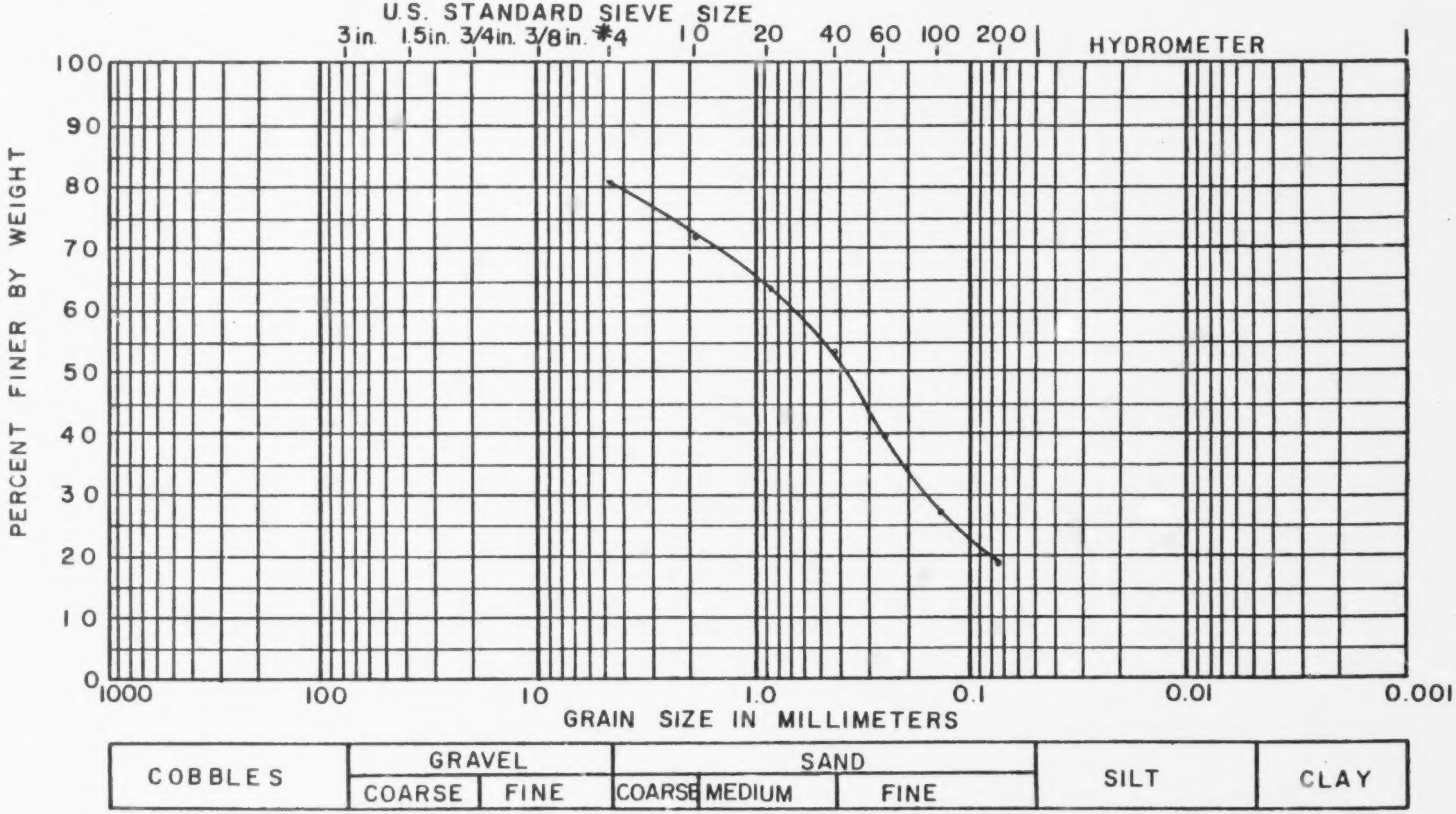
PLATE B-2



GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING

BORING NO. TP-9
DEPTH 7.0' - 8.0'
PROJECT Ree's Corner Landfill Site

W.O. 1035-62
PLATE B-3



GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING

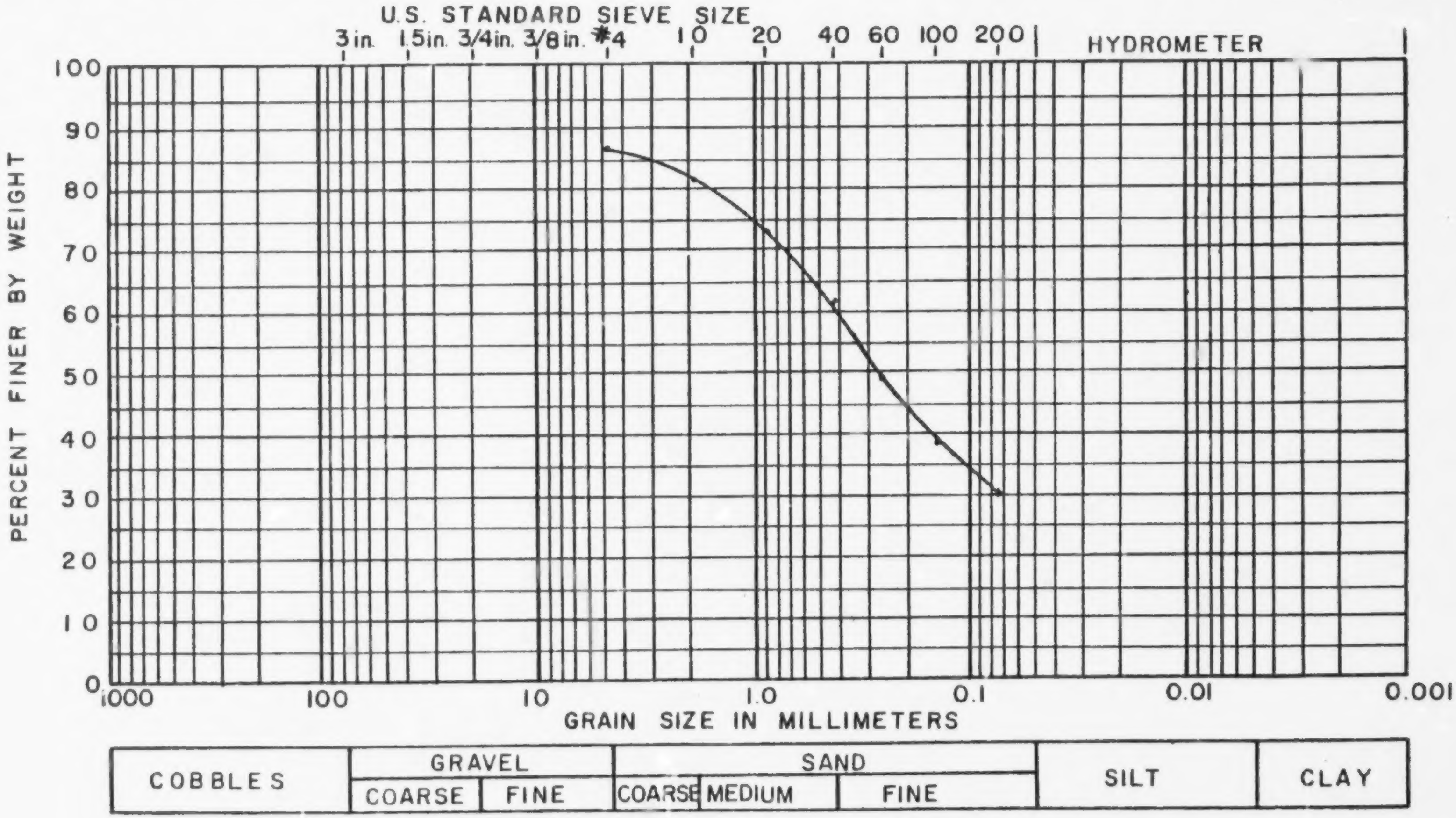
BORING NO. TP-10

DEPTH 0.5' - 3.0'

PROJECT Ree's Corner Landfill Site

W.O. 1035-62

PLATE B-4



APPENDIX E

CATHCART SANITARY LANDFILL SITE

SNOHOMISH COUNTY

W-1035 -64

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CATHCART SANITARY LANDFILL SITE

SNOHOMISH COUNTY

W-1035-64

FOR

STEVENS, THOMPSON & RUNYAN, INC.
700 Plaza 600
Seattle, Washington

FEBRUARY 1974

By

GEOLABS-WASHINGTON, INC.
Soils Mechanics and Foundation Engineers
12893 N. E. 15th Place
Bellevue, Washington

SUMMARY

This report presents the results of our final subsurface investigation of the proposed Cathcart Sanitary Landfill Site. The site is located four miles south of the town of Snohomish, on the west side of State Highway 9 (Woodinville Cut-off). Except for approximately ten acres which have been cleared and used as pasture, most of the site is covered by young second growth timber and logging slash, overgrown by berry vines. The most northerly eighty acres are covered by older second growth timber, some of marketable size.

The entire property comprises roughly two hundred acres of which the most northerly forty would be a buffer zone and site for a sanitary treatment plant, if required. Buffer zones would also be provided around the periphery of the site to protect adjacent landowners and their property. The sanitary landfill, according to preliminary plans, would be a cut and cover operation in which each day's refuse would be covered by soil.

The site is underlain by soft to moderately hard, gray, silty Sandstone at depths ranging from six inches to forty-two feet. Atop bedrock, beneath the ridges which flank the two sides of the property, are very dense, moist to wet, brown or gray, silty, gravelly Sands (Glacial Till). Within the swale, between the two ridges, are stream deposited, loose to dense and very dense, wet, brown or gray, silty, gravelly Sands and soft Silts over the bedrock stratum. Water was noted on the site, in a pair of northward flowing streams, which join roughly 3200 feet north of the south property line. Groundwater was observed in the borings at depths ranging from one and one-half to twenty-four

feet below the ground surface. Backhoe test pits encountered seepage at various depths, up to within six inches of the ground surface, in winter time.

In all of the borings, upon penetrating into the silty sandstone bedrock, surface waters were cut off, resulting in dry holes during drilling.

This report presents specific recommendations concerning excavation and use of the site soils in the landfill, ground and surface water management and leachate control, and other appropriate design considerations. Included with the report are descriptions of the site geology and soil conditions, hydrology, a description of the exploration methods utilized and the laboratory test program results.

DESIGN CONSIDERATIONS

I. General

The proposed Cathcart Sanitary Landfill site appears to be well suited for solid waste disposal. The two most critical considerations in the development of a landfill are separation of leachate from ground or surface waters and soils suitable for use as cover material. Due to the relatively impervious nature of the till and underlying sandstone, loss of leachate should be relatively easy to control. Due to their density and high silt content, the till and rock may, however, be difficult to excavate and place, especially during wet weather.

II. Groundwater and Leachate Control

The silty sandstone and glacial till are, based upon our drilling, laboratory testing and inspection of the property during rainy weather, relatively impervious. As a result, it would be possible to intercept the perched groundwater and surface runoff on the site with a system of perimeter drains around the property. The drainage system may be designed as an open ditch, a ditch lined with an impervious membrane on the side closest to the landfill, a ditch filled with a coarse, granular, free draining material, or a combination of the above. Where installed adjacent to the south property line, such an interceptor would need to extend from five to ten feet below the existing ground surface to pick up water flowing atop the impervious sandstone or glacial till.

In order to further minimize infiltration of water (rainfall), the daily cover should, if possible, be constructed with the relatively silty, onsite soils. By compacting and sloping this cover to improve drainage, infiltration into the refuse may be reduced.

Leachate which is generated, should be intercepted downslope from the refuse in an appropriate system of drains and collectors. This leachate may require treatment and/or dilution prior to disposal.

In isolated areas along the west side of the site, thin permeable sand beds, on the order of two feet thick, may be encountered between the surface of the sandstone and the base of the impervious till. This sand may form the east edge of a widespread, permeable aquifer. In order to prevent loss of leachate through this stratum, it will be necessary to provide an impervious cutoff or blanket across each sand exposure, as it is encountered. The leachate barrier may be constructed of suitably compacted silty soils, if blanketing can be performed during dry weather. Otherwise a membrane such as PVC or asphalt may be necessary.

If soil is used for the leakage barrier, the material used should be glacial till or any other silty onsite soil. Grading should be performed during dry weather, with the soil as close to optimum moisture content as possible. The soil should be placed in eight-inch thick layers, loose depth, and compacted to at least 90% of laboratory maximum density using ASTM Method: D-1557-70 or AASHO: T-180 as a standard. Compaction should be performed with a sheepsfoot type roller rather than a vibratory or smooth drum, to prevent the development of planes of greater and lesser compaction. Compaction should be performed under the supervision of a qualified soils engineer.

The width of the leakage barrier should be based upon laboratory permeability determinations made on recompacted glacial till. Typical rates of 1 to 2.5 x 10^{-5} cm/sec were measured on till samples obtained from boring B-6. In any case, due to equipment size limitations, a minimum barrier width of eight feet (dozer or compactor width) should be considered.

III. Soils

Due to their density and high silt content, difficulty may be encountered in excavating and utilizing the till and sandstone. These materials will require relatively heavy equipment for excavation (D-7 or D-8 Cat). They may also tend to remain in blocks or clods when excavated, so that satisfactory compaction may be difficult, requiring several passes of the equipment to break up. The high silt content of most of the onsite materials, from fifteen to fifty-one percent, will cause these soils to be moisture sensitive. This means that, if the soil contains more water than two or three percent over optimum, it will be impossible to adequately compact it. This becomes especially critical with the till which normally is at or slightly over optimum moisture.

Due to the relatively impervious nature and high silt content of the onsite soils, some method of gas collection and release will be necessary. This may be accomplished by importing a granular soil (sand or gravel) and placing it as a continuous cover atop the refuse. Otherwise, a network of gas collectors or vents of some type should be installed. A review of gravel sources, including test results on the material available has been reported previously. (Geolabs Report: W-1035-65 dated January 22, 1974)

IV. Slopes

Temporary excavations in the till or sandstone, when not subject to seepage or flowing water, should be stable at slopes approaching 1H:1V, although localized sloughing in deep excavations may occur. The less dense stream deposits, if dewatered, should remain stable at slopes of 2H:1V. When continuously wet or subject to seepage, any of the cut slopes will become unstable and may slough back to slopes flatter than 3H:1V in till or 10H:1V in soft silts and loose sands.

Temporary uncompacted stockpiles of soil, if protected from rainfall, should stand with slopes of 3H:1V. If they are not protected from the weather, they will gully and erode severaly possibly resulting in slopes of 5H or 10H: 1V, or flatter. Compacted fill slopes, especially the refuse cover, should remain stable at slopes of 3H:1V or flatter. These permanent slopes should, however, be protected from gullying by drainage benches and berms planting, and if deemed appropriate, a covering such as plastic sheeting or a thin film binder such as Land Lock (TM) by the 3M Company.

V. Roads

The site roads will require some surface treatment at all times of the year. During wet weather, the soils, if unprotected, will rut, gully, and pump under traffic until they become impassable. In summer, the same soils will produce dust unless they are stabilized. Stabilization may include gravel surfacing, seal coatings or wood waste (hog fuel) fills.

HYDROLOGY

Rainfall in the vicinity of the site is reported to be in excess of thirty inches per year, concentrated during the winter months. This heavy rainfall is incapable of penetrating into the till and sandstone in appreciable quantities, but instead, flows downslope to collect in the various kettles and potholes, or to the two streams which cross the site. These northward flowing streams represent the surface of the perched groundwater table which is trapped atop the glacial till and sandstone.

Groundwater and surface water rise during winter and spring to their highest levels and drop during the summer. Based upon surface area calculations from the USGS Quadrangle sheet, we have determined that the surface area providing groundwater recharge is in excess of 985 acres. Due to the generally impermeable nature of the soils within the drainage basin, most of the rainfall should reach and/or flow through the site, rather than penetrating into a deep aquifer.

A review of all of the water well logs submitted to the State of Washington, Department of Ecology and contacts with local well drillers, indicate that wells in the immediate vicinity of the site obtain water from perched sources atop the glacial till, from permeable lenses within the till, or from floodplain deposits of the Snohomish River valley. Only one well is reported to obtain water from the basalt underlying the sandstone. This well for the Cathcart School, is located approximately one mile north of the site and draws water from a fractured horizon about 140 to 150 feet below the surface. With some 500 feet of sandstone stratigraphically overlying the basalt, entry of leachate into this aquifer is unlikely.

GEOLOGY

The Cathcart site is underlain at depths ranging from six inches to forty-nine feet by a soft to moderately hard, gray, silty Sandstone, which weathers to a brown or tan color. The sandstone is massive, with poorly developed bedding, although occasional shale partings were observed in some backhoe pits and boring samples. The sandstone, according to the county geologic report, is of Oligocene age, and may be on the order of 500 feet thick. Beneath it are older basaltic rocks.

Overlying the sandstone, atop the high ground, is a very dense, moist, brown to gray, silty, gravelly Sand (Glacial Till). This material was deposited by glacial ice, as the glacier traveled southward through the area. The till is a lodgement till, having been smeared or plastered across the underlying sandstone. Glaciation and till emplacement occurred some 13,000 to 15,000 years ago.

West and south of the site, fine to coarse sands of the Esperance sand, have been encountered between the base of the glacial till and the surface of the Sandstone. This sand may extend in an isolated area along the west margin of the site onto the property. The material represents the outwash sands, carried by meltwater streams issuing from the approaching glacier. With passage of the ice sheet, these soils were consolidated and compacted along with the overlying glacial till.

As the ice sheet melted and wasted away, streams issuing from the ice front and from remnant blocks of ice left behind on the uplands, coupled with rain and snow, carved a draw through the till to bedrock. This breach through the till has subsequently been partially filled by post glacial, recessional, loose to dense, brown or gray sands, silty sands and silty, gravelly sands with some silt beds.

Localized kettles or potholes in the till surface exist, especially near the west margin of the property. These relatively small isolated basins contain soft silts and clays, with saturated sands and a near surface mat of peat or highly organic soil.

SUBSURFACE CONDITIONS

The basal material underlying the entire site is a soft to moderately hard, gray, silty sandstone, which, near the ground surface, weathers to light tan and brown. This rock is a massive to thin bedded sediment with scattered thin shale partings. Test drilling and onsite water level observations in the borings indicate that the sandstone is only slightly permeable.

Overlying the sandstone is a cap of glacial till atop the high ground along the east and west sides of the parcel. The till is a nearly impervious, very dense mixture of gravel, silt and sand, which has been thoroughly compacted and consolidated by more than 3500 feet of glacial ice.

In the draw between the two low ridges are loose to dense, wet, gray, brown or reddish brown, silty sands and silty, gravelly sands and some soft to medium stiff silts. Within localized, small kettles and potholes atop the till are loose, wet, blue-gray sands, soft silts and clays, and very soft, brown peat and organic debris.

Along the west margin of the site, a two foot thick layer of medium dense, medium to fine sands was encountered in one of the backhoe pits. This sand may be part of the surficial, weathered bedrock, or may be a portion of the Esperance sand formation. If these soils are part of the Esperance sands, they would represent the easternmost edge of a wedge shaped formation which extends for a considerable distance to the south and west, and is, in some areas, utilized as an aquifer to supply water wells.

Groundwater is present perched atop the relatively impermeable sandstone and glacial till, saturating the granular surficial materials. During the winter rainy season, groundwater levels rise to the surface creating a series of ponds and swamps, plus a pair of north flowing streams. The drainage area feeding towards the site covers 785 acres. The steeply descending slopes, north of the site, effectively prevent backup of groundwater levels. Instead, waters, both surface and subsurface, are capable of draining across the site.

SUBSURFACE INVESTIGATION

During this phase of our investigation, we have drilled a total of eight test borings across the site with a truck-mounted, hollow stem auger. The borings range in depth from eleven to forty-nine feet. In each of the borings, Standard Penetration Test samples were obtained at five foot or shorter intervals. The Standard Penetration Test consists of driving a two-inch O.D. split spoon sampler eighteen inches into the soil with a 140-pound hammer free falling a distance of thirty inches. The number of blows required to drive the sampler the last twelve inches is termed the Standard Penetration Resistance (N value) and gives an indication of the in situ density or consistency of the soil.

The materials obtained by this method were visually classified in the field and representative portions were placed in airtight glass jars and returned to our laboratory for testing. Each of the borings was provided with a one and one-half inch diameter piezometer to permit monitoring of groundwater level fluctuations and water sampling.

Coupled with the test drilling program, a series of twenty-five backhoe test pits were excavated to more accurately delineate the nature, depth and condition of the bedrock, glacial till and near surface soils.

The approximate boring and test pit locations are presented on Plate 1, Site Plan. The boring logs, showing materials encountered, sample locations, N values, and depths to water are presented on Plates A-1 through A-9. The test pit logs are presented in Table A.

LIMITATIONS

Due to restrictions placed upon our exploration program by the property owners, test drilling and backhoe work was not performed at the north end of the landfill site. Upon completion of clearing and development of adequate access, we will perform additional test drilling in this area to verify the condition of the soils, the depth to impervious strata, and the depth to bedrock. We are confident, based upon our visual inspection and review of available data, that conditions beneath the area in question will be similar to the explored portions of the property to the south.

We appreciate this opportunity to be of service. If you have any questions regarding this report, please feel free to call us.

Respectfully submitted,

GEOLABS-WASHINGTON, INC.

Tom Bekey mh

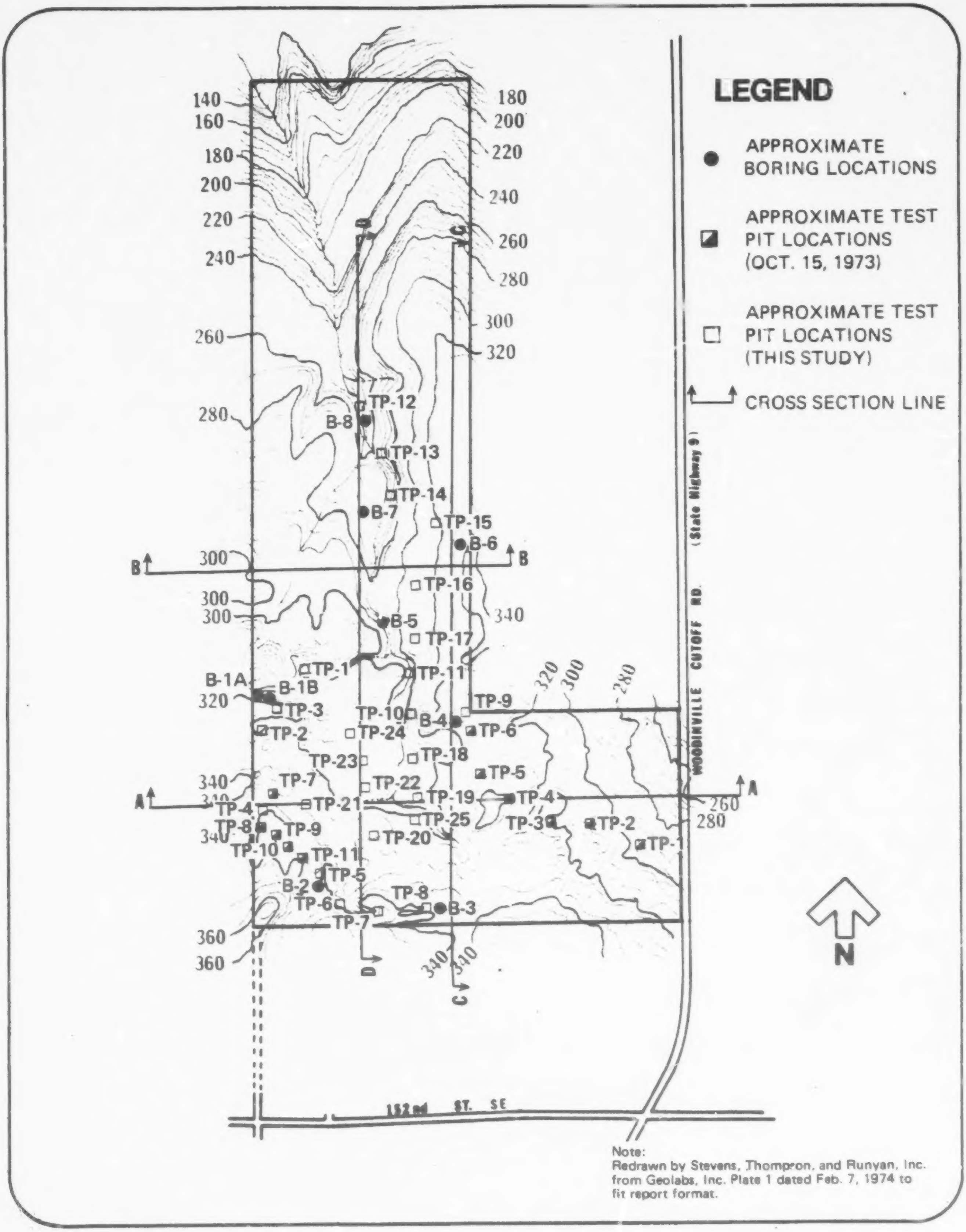
Tom Bekey, Engineering Geologist

John J. Heneghan

John J. Heneghan, P.E.

JOHN J. HENEGHAN

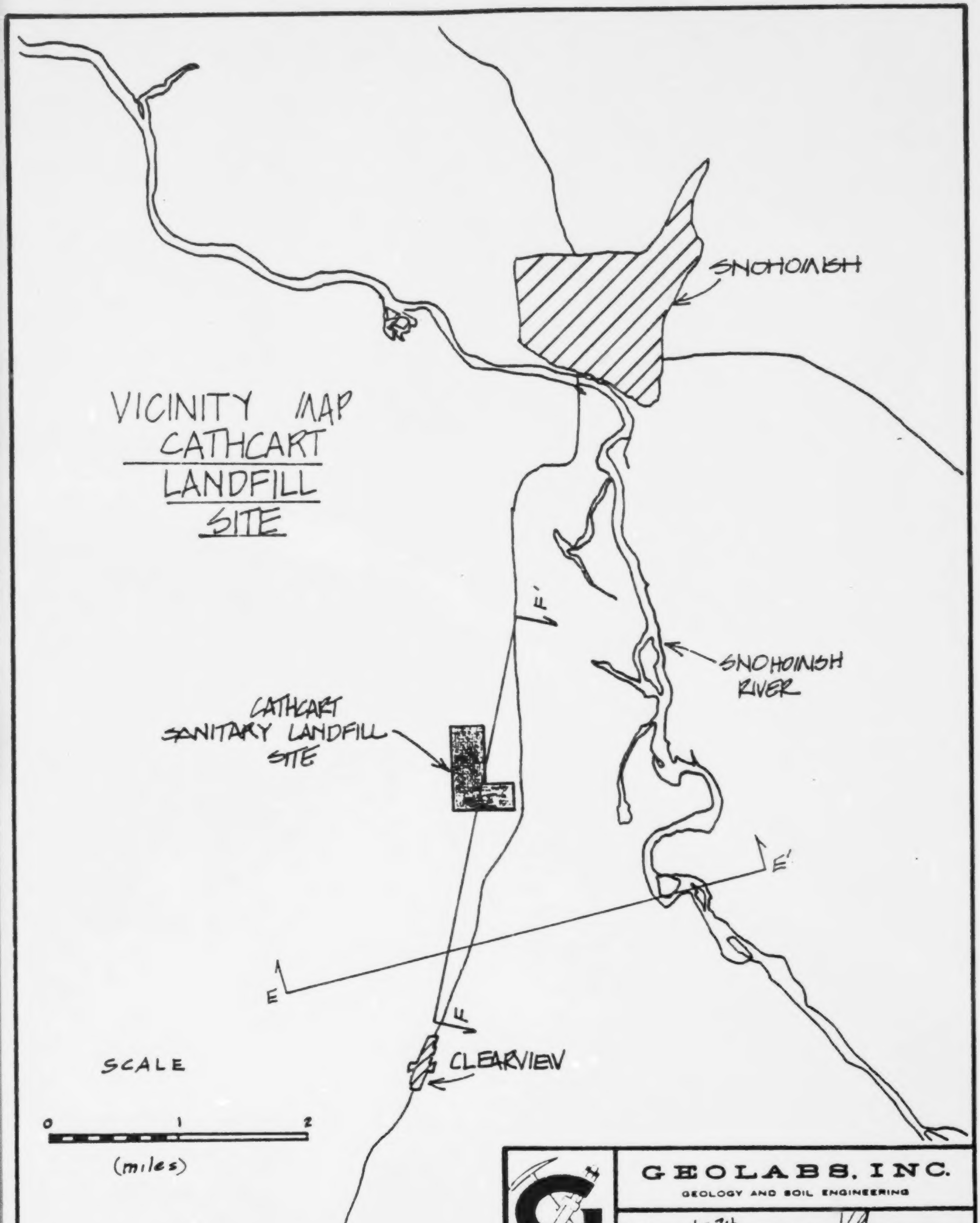
JJH/mh


LEGEND
● APPROXIMATE BORING LOCATIONS
◪ APPROXIMATE TEST PIT LOCATIONS (OCT. 15, 1973)
☐ APPROXIMATE TEST PIT LOCATIONS (THIS STUDY)
CROSS SECTION LINE
N
WOODINVILLE CUTOFF RD. (State Highway 9)
152nd ST. SE
A
B
C
D
B-1A
B-1B
B-2
B-3
B-4
B-5
B-6
B-7
B-8
TP-1
TP-2
TP-3
TP-4
TP-5
TP-6
TP-7
TP-8
TP-9
TP-10
TP-11
TP-12
TP-13
TP-14
TP-15
TP-16
TP-17
TP-18
TP-19
TP-20
TP-21
TP-22
TP-23
TP-24
TP-25
140
160
180
200
220
240
260
280
300
320
340
360

Note:
Redrawn by Stevens, Thompron, and Runyan, Inc. from Geolabs, Inc. Plate 1 dated Feb. 7, 1974 to fit report format.

SOIL PROFILE LOCATIONS

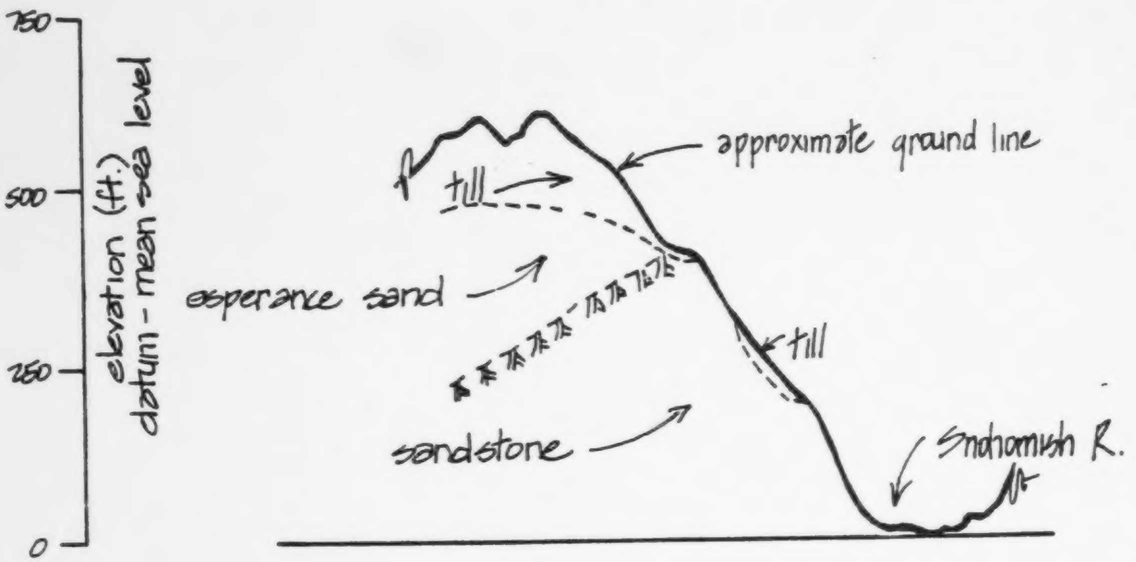
PLATE 1


VICINITY MAP
CATHCART
LANDFILL
SITE
SNOHOMISH
SNOHOMISH
RIVER
CATHCART
SANITARY LANDFILL
SITE
F'
F
E'
E
CLEARVIEW
SCALE
0
1
2
(miles)

GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING

DATE 1-74 BY
SCALE W.O. 1035-64

PLATE 1A


750
500
250
0
elevation (ft.)
datum - mean sea level
approximate ground line
till
esperance sand
till
sandstone
Snohomish R.

SECTION EE'
VICINITY—
CATHCART SANITARY
LANDFILL SITE

NOTE: - vertical exaggeration is 21 times
- dashed lines indicate only approximate areas of soil strata

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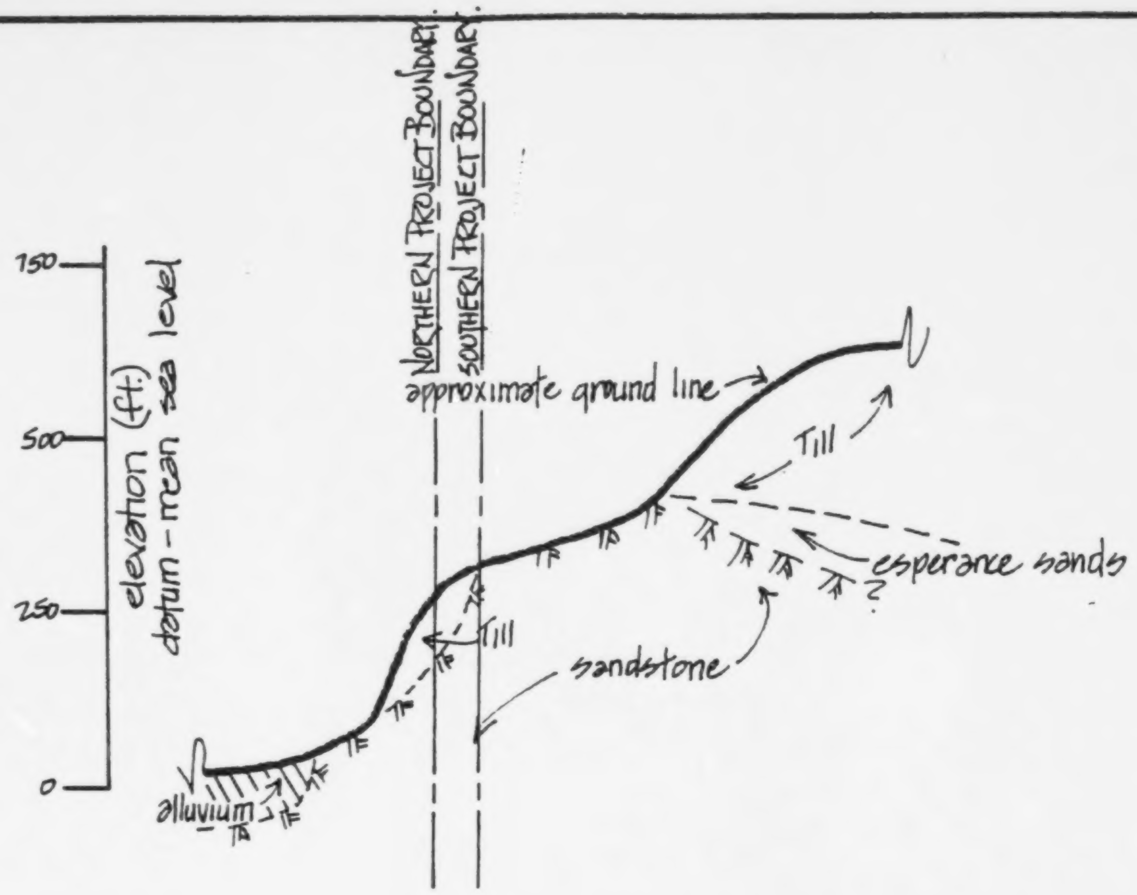
12893 N. E. 15TH PLACE
BELLEVUE, WASHINGTON 98005
(206) 455-2018

502 SOUTH 11TH STREET
TACOMA, WASHINGTON 98402
(206) 272-4347

OFFICES IN MOST PRINCIPAL CITIES

W.O.	1035-64	DATE	1-74
BY	KG	SCALE	V: 1" = 250' H: 1" = 1 mile

PLATE 2


750
500
250
0
elevation (ft.)
datum - mean sea level
NORTHERN PROJECT BOUNDARY
SOUTHERN PROJECT BOUNDARY
approximate ground line
Till
esperance sands
?
Till
sandstone
alluvium
TA
TF

SECTION FF'
VICINITY -
CATHCART SANITARY
LANDFILL SITE

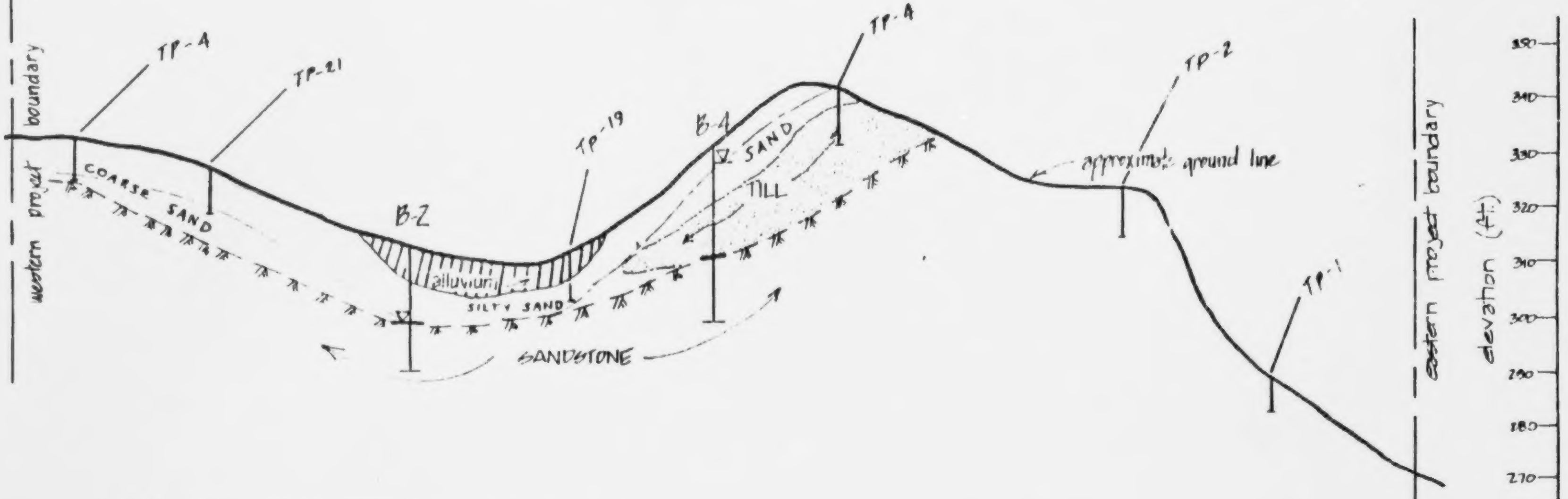
NOTES: -vertical exaggeration is
2, times
-dashed lines indicate only
approximate areas of soil strata

GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING
DATE 1-74 BY KY
SCALE V: 1" = 250' H: 1" = 1 mile NO. 1035-64

PLATE 2A

SECTION AA'

CATHCART LANDFILL SITE


western project boundary
TP-A
TP-21
COARSE SAND
B-2
alluvium
SILTY SAND
TP-19
SANDSTONE
B-4
SAND
TILL
TP-A
approximate ground line
TP-2
TP-1
eastern project boundary
elevation (ft.)
350
340
330
320
310
300
290
280
270

NOTES
1) vertical exaggeration is 10 times
2) dashed lines indicate only estimated projections of soil strata
3) boring and test pit locations have been projected to section line
4) — - — - indicates piezometric surface

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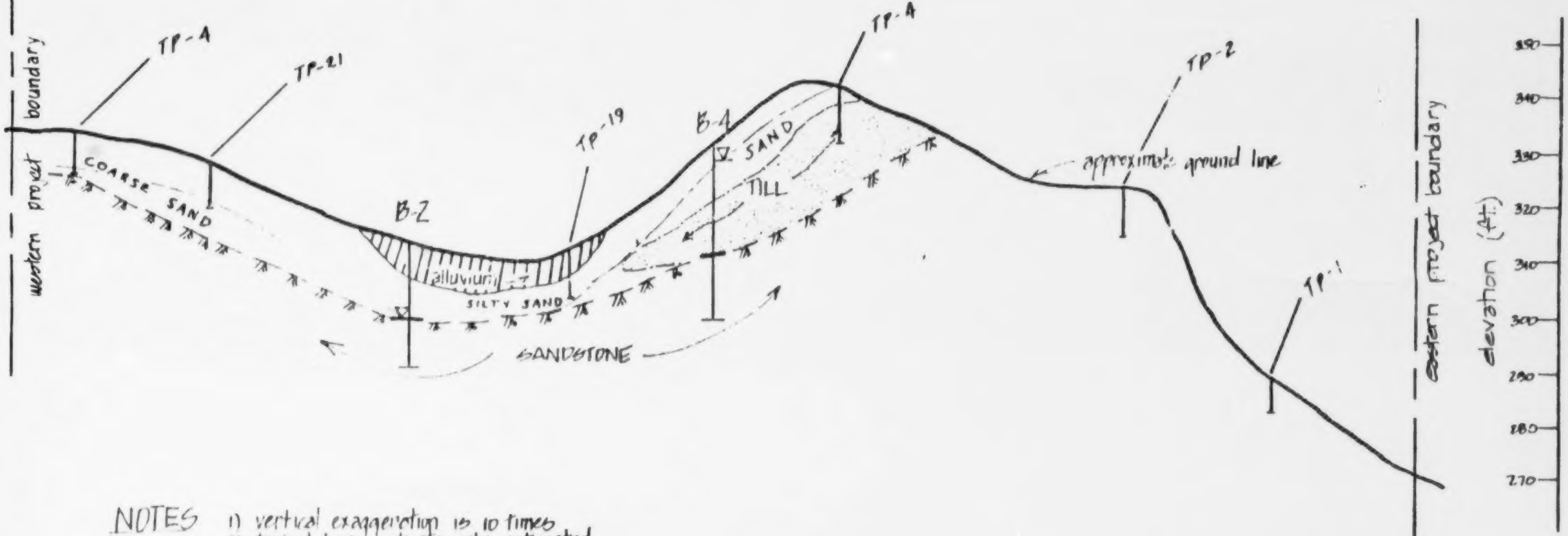
[illegible] N.E. [illegible] PLACE
BELLEVUE, WASHINGTON [illegible]
[illegible]
[illegible] SOUTH [illegible] STREET
TACOMA, WASHINGTON [illegible]
[illegible]
OFFICES IN MOST PRINCIPAL CITIES

WO 1039-64	DATE 1-74
BY J-?	SCALE V. 1"=25' H. 1"=200'

SECTION AA'
CATHCART LANDFILL SITE


western project boundary
TP-A
TP-21
COARSE SAND
B-2
alluvium
SILTY SAND
TP-19
B-4
SAND
TILL
TP-A
SANDSTONE
approximate ground line
TP-2
TP-1
eastern project boundary
elevation (ft)
350
340
330
320
310
300
290
280
270

NOTES
1) vertical exaggeration is 10 times
2) dashed lines indicate only estimated projections of soil strata
3) boring and test pit locations have been projected to section line
4) — - — indicates piezometric surface

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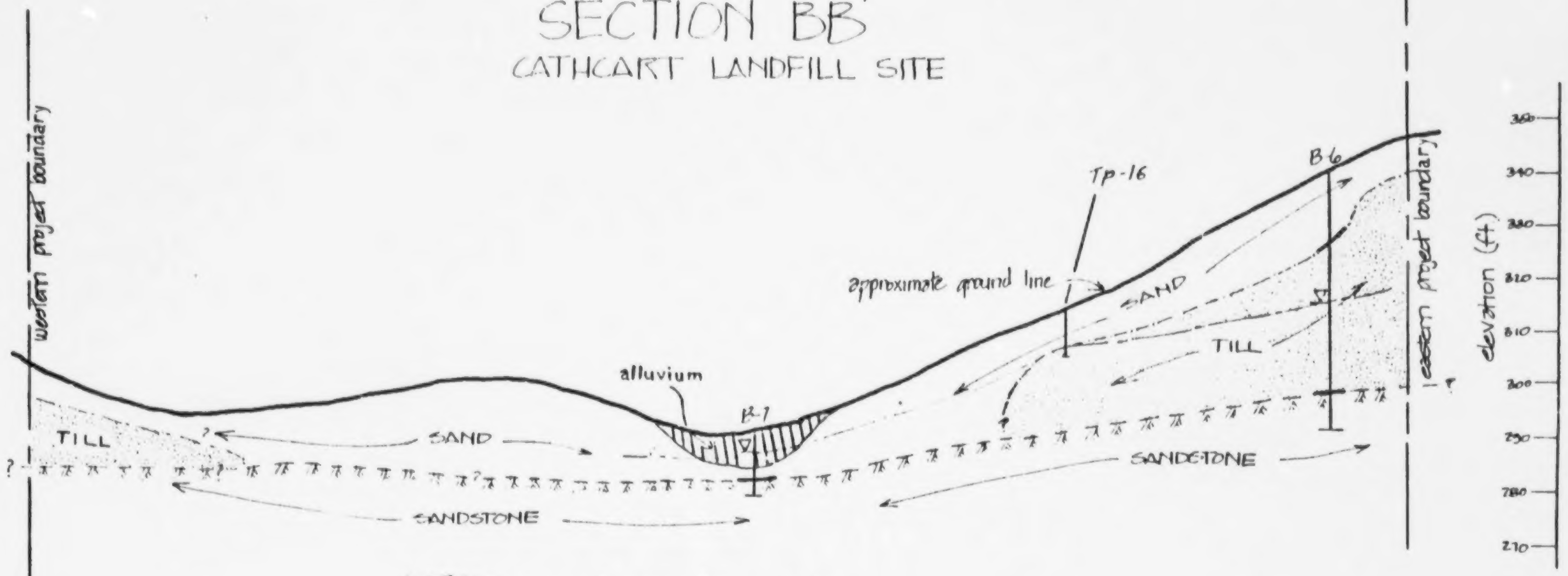
BELLEVUE, WASHINGTON [illegible]
[illegible]
[illegible] SOUTH [illegible] STREET
TACOMA, WASHINGTON [illegible]
[illegible]
OFFICES IN MOST PRINCIPAL CITIES

WO 1029-64
BY [illegible]
DATE 1-74
SCALE V: 1" = 25' H: 1" = 140'

SECTION BB'

CATHCART LANDFILL SITE

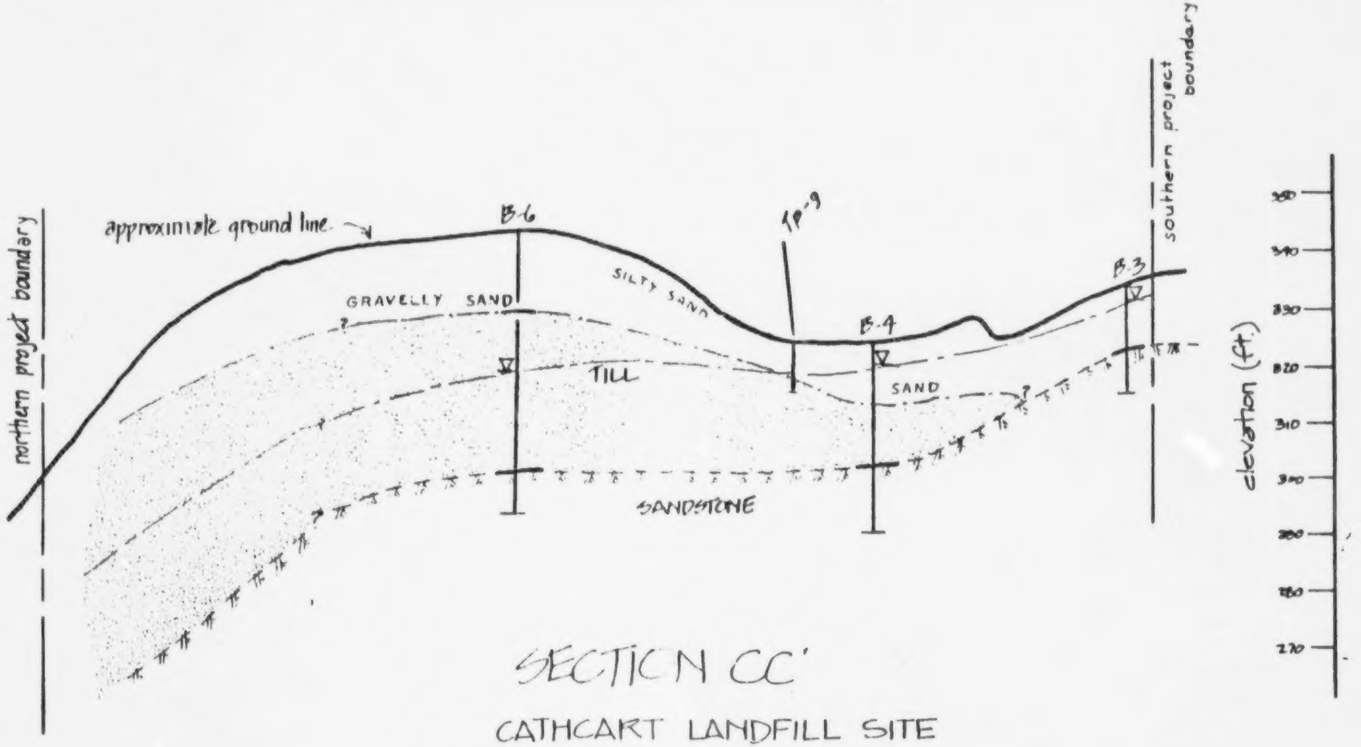

western project boundary
eastern project boundary
alluvium
B-7
Tp-16
B-6
approximate ground line
SAND
TILL
SAND
TILL
SANDSTONE
SANDSTONE
elevation (ft)
360
340
330
320
310
300
290
280
270

NOTES
1) vertical exaggeration is 5 times
2) dashed lines indicate only estimated projections of soil strata
3) boring and test pit locations have been projected to section line.
4) — - —ᵛ- indicates piezometric surface

GEOLABS, INC.
GEOLOGY AND SOILS ENGINEERING
OFFICES IN MOST PRINCIPAL CITIES

WO 1037-69 DATE 1-74
BY KA SCALE V. 1" = 20'. H. 1" = 100'

PLATE 4


northern project boundary
approximate ground line
B-6
TP-9
B-4
B-3
southern project boundary
GRAVELLY SAND
SILTY SAND
TILL
SAND
SANDSTONE
elevation (Ft.)
350
340
330
320
310
300
290
280
270

SECTION CC'

CATHCART LANDFILL SITE

NOTES:
1) vertical exaggeration is 20 times
2) dashed lines indicate only estimated projections of soil strata.
3) boring and test pit locations have been projected to section line.
4) —·—·— indicates piezometric surface

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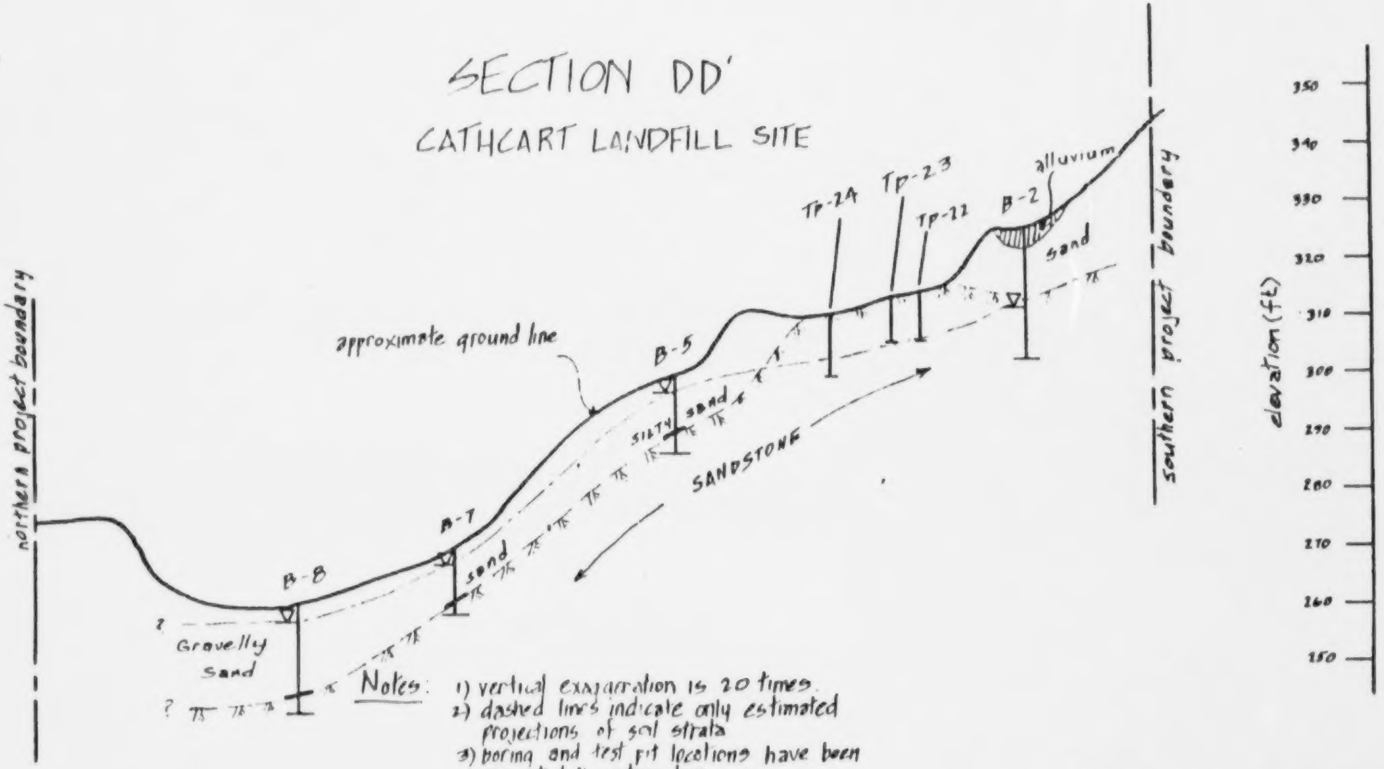
BELLEVUE WASHINGTON [illegible]
[illegible]
[illegible] SOUTH [illegible] STREET
TACOMA WASHINGTON [illegible]
[illegible]
OFFICES IN MOST PRINCIPAL CITIES

WO 1095-64 DATE 1-74
BY KA SCALE V: 1"=20' H: 1"=400'

PLATE 6

SECTION DD'

CATHCART LANDFILL SITE


northern project boundary
southern project boundary
approximate ground line
B-8
B-7
B-5
B-2
Tp-24
Tp-23
Tp-22
alluvium
sand
silty sand
sand
Gravelly Sand
SANDSTONE
?
elevation (ft)
350
340
330
320
310
300
290
280
270
260
250

Notes:
1) vertical exaggeration is 20 times.
2) dashed lines indicate only estimated projections of soil strata
3) boring and test pit locations have been projected to section line.
4) — — — — indicates piezometric surface

GEOLABS, INC.
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BELLEVUE WASHINGTON [illegible]
[illegible]
[illegible] SOUTH [illegible] STREET
TACOMA WASHINGTON [illegible]
[illegible]
OFFICES IN MOST PRINCIPAL CITIES

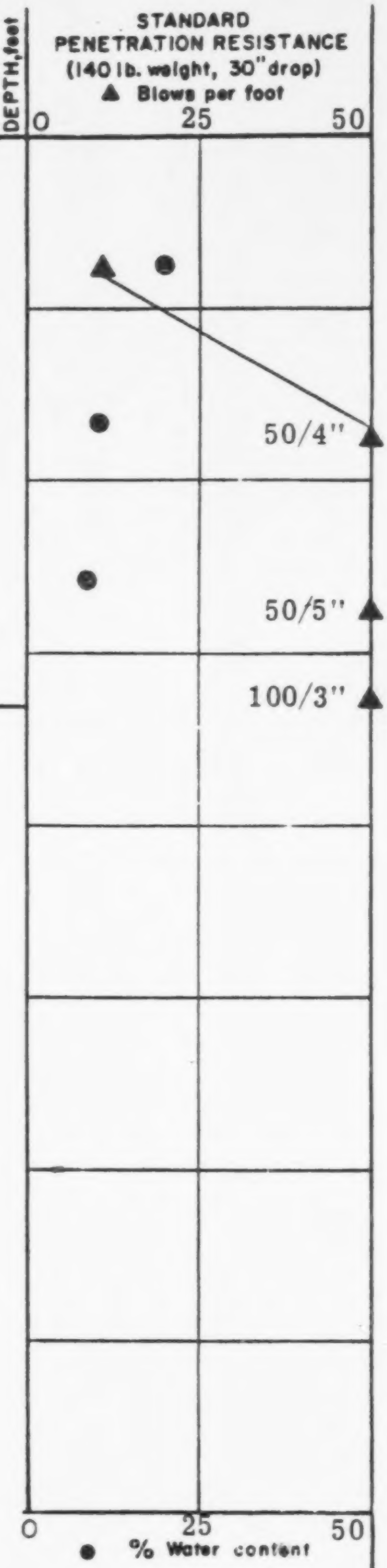
NO 1086-64
BY hg
DATE 1-74
SCALE V: 1" = 20', H: 1" = 400'

Att. 1

APPENDIX A

EXPLORATION LOGS

DEPTH, feet	USC	SOIL DESCRIPTION Surface Elevation: ± 325'	SAMPLES
0–5	SM	Loose to medium dense, moist, brown, silty SAND.	I
5	GM	Very dense, moist, brown, silty, gravelly SAND.	I
10	GM	Very dense, moist, brown to gray, silty, gravelly SAND. Top of Rock 14.5 ft.	I
15		Rock.	I
		Bottom of hole at 16.5 ft.	
20			



LEGEND

I 2.0" O.D. split spoon sample
II 3.0" O.D. thin-wall sample
* Sample not recovered
Atterberg limits:
Liquid limit
Natural water content
Plastic limit
Impervious seal
Water level
Piezometer tip
P Sampler pushed
USC Unified Soil Classification

Cathcart Sanitary Landfill Site

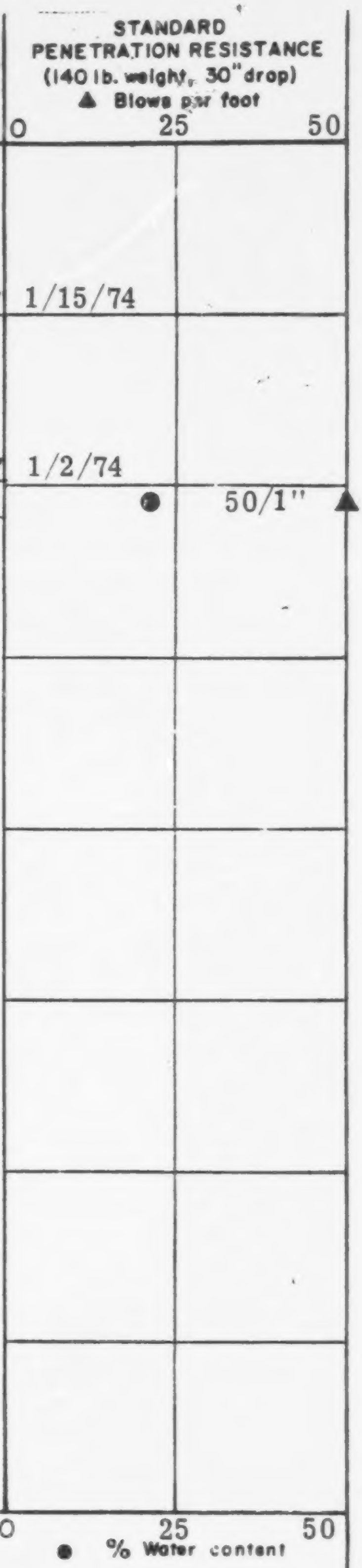
LOG OF BORING NO. B-1A

W-1035-64

GEOLABS, INC.

SOIL MECHANICS & FOUNDATION ENGINEERS

DEPTH, feet	USC	SOIL DESCRIPTION Surface Elevation: ± 320'	SAMPLES	DEPTH, feet
0–9	SM GM	Medium dense to dense, moist, brown, silty, gravelly SAND.		▽ 1/15/74 (5)
10	SM	Very dense, moist to wet, gray, silty SAND. Top of rock at 11.0 ft.	I	▽ 1/2/74 (10); ■
11		Bottom of hole at 11.0 ft.		
15				



LEGEND

I 2.0" O.D. split spoon sample
II 3.0" O.D. thin-wall sample
* Sample not recovered
Atterberg limits:
├─●─┤ ← Liquid limit
— Natural water content
— Plastic limit

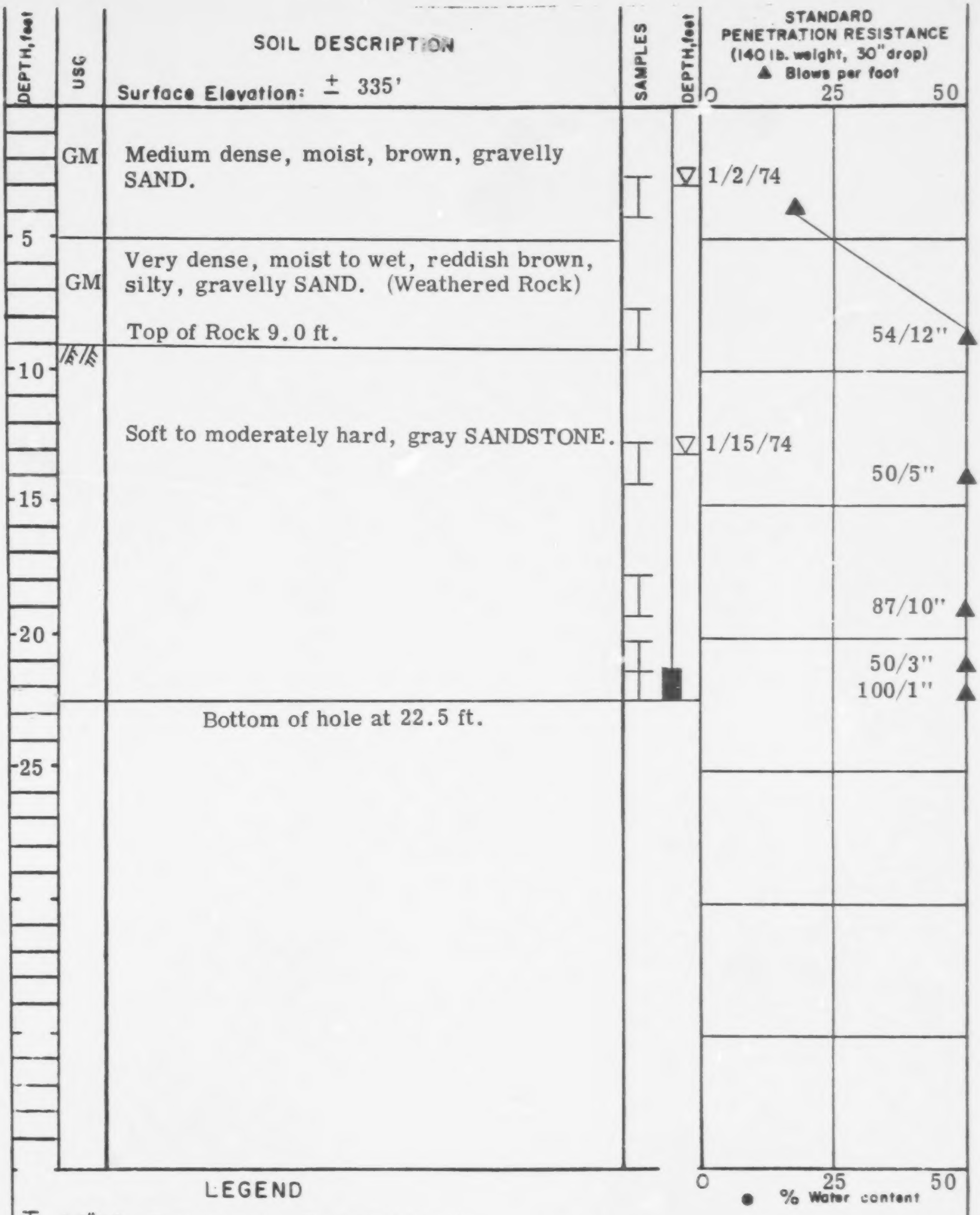
Impervious seal
▽ Water level
■ Piezometer tip
P Sampler pushed
USC Unified Soil Classification

Cathcart Sanitary Landfill Site

LOG OF BORING NO. B-1B

W-1035-64

GEOLABS, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS



DEPTH, feet
USG
SAMPLES
DEPTH, feet
5
10
15
20
25
GM
GM
1/2/74
1/15/74
54/12"
50/5"
87/10"
50/3"
100/1"
0
25
50
0
25
50
● % Water content

SOIL DESCRIPTION

Surface Elevation: ± 335'

STANDARD PENETRATION RESISTANCE (140 lb. weight, 30" drop)

▲ Blows per foot

Medium dense, moist, brown, gravelly SAND.

Very dense, moist to wet, reddish brown, silty, gravelly SAND. (Weathered Rock)

Top of Rock 9.0 ft.

Soft to moderately hard, gray SANDSTONE.

Bottom of hole at 22.5 ft.

LEGEND

I	2.0" O.D. split spoon sample		Impervious seal
II	3.0" O.D. thin-wall sample	▽	Water level
*	Sample not recovered	■	Piezometer tip
		P	Sampler pushed
		USC	Unified Soil Classification

Atterberg limits:
Liquid limit
Natural water content
Plastic limit

Cathcart Sanitary Landfill Site

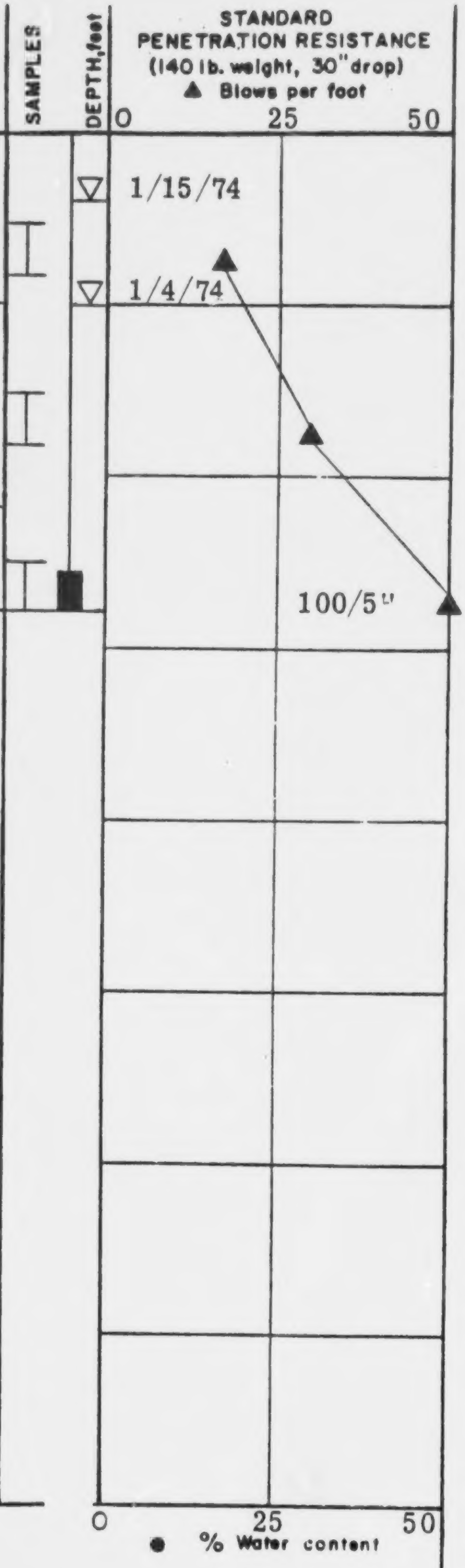
LOG OF BORING NO. B-2

W-1035-64

GEOLABS, INC.

SOIL MECHANICS & FOUNDATION ENGINEERS

DEPTH, feet	USC	SOIL DESCRIPTION Surface Elevation: ± 340'
	SM	Medium dense, wet, brown, silty, gravelly, fine SAND.
5	SM	Dense, wet, gray, gravelly, silty, fine SAND.
10		Top of Rock 11.0 ft.
		Soft to moderately hard, gray SANDSTONE.
15		Bottom of hole at 19.0 ft.



LEGEND

Ⅰ 2.0" O.D. split spoon sample
Ⅱ 3.0" O.D. thin-wall sample
* Sample not recovered
Atterberg limits:
Liquid limit
Natural water content
Plastic limit

Impervious seal
▽ Water level
■ Piezometer tip
P Sampler pushed
USC Unified Soil Classification

Cathcart Sanitary Landfill Site

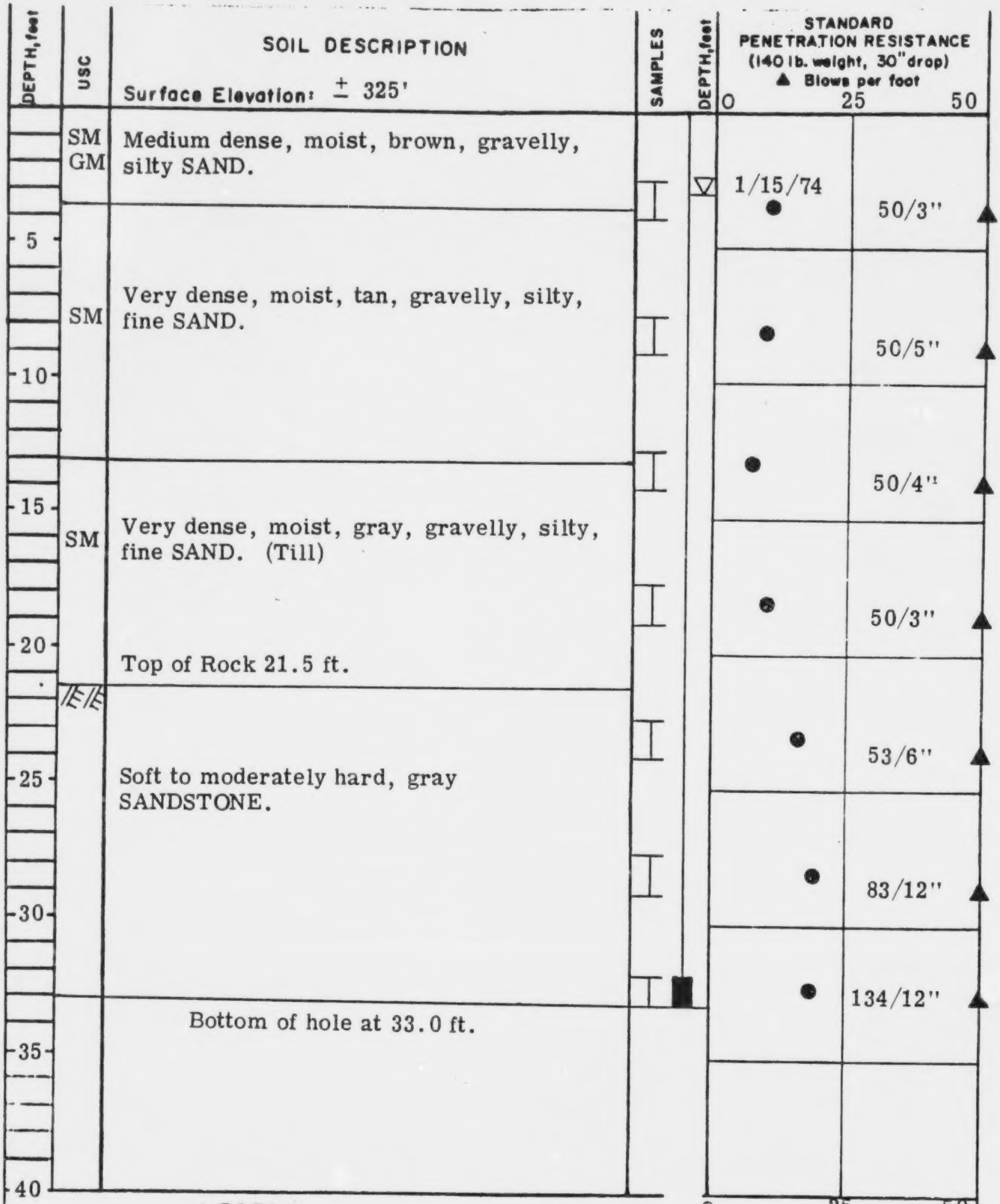
LOG OF BORING NO. B-3

W-1035-64

GEOLABS, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS

SOIL DESCRIPTION

Surface Elevation: ± 325'


DEPTH, feet
SAMPLES
DEPTH, feet
STANDARD PENETRATION RESISTANCE
(140 lb. weight, 30" drop)
▲ Blows per foot
0
25
50
5
10
15
20
25
30
35
40
1/15/74
50/3"
50/5"
50/4"
50/3"
53/6"
83/12"
134/12"
0
25
50
● % Water content

USC	SOIL DESCRIPTION
SM GM	Medium dense, moist, brown, gravelly, silty SAND.
SM	Very dense, moist, tan, gravelly, silty, fine SAND.
SM	Very dense, moist, gray, gravelly, silty, fine SAND. (Till) Top of Rock 21.5 ft.
	Soft to moderately hard, gray SANDSTONE.
	Bottom of hole at 33.0 ft.

LEGEND

I 2.0" O.D. split spoon sample
II 3.0" O.D. thin-wall sample
* Sample not recovered

Atterberg limits:
Liquid limit
Natural water content
Plastic limit

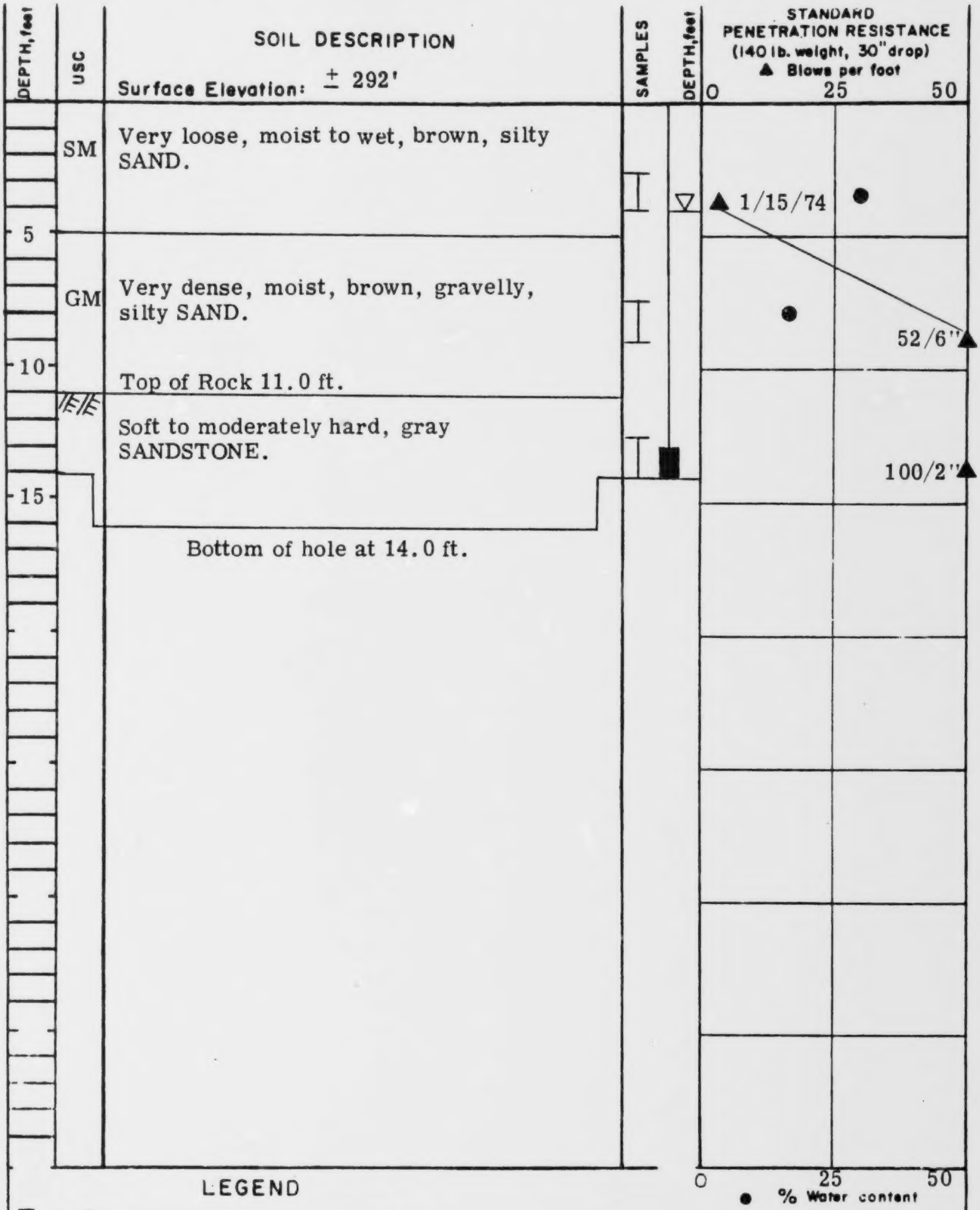
Impervious seal
▽ Water level
▮ Piezometer tip
P Sampler pushed
USC Unified Soil Classification

Cathcart Sanitary Landfill Site

LOG OF BORING NO. B-4

W-1035-64

GEOLABS, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS


DEPTH, feet
USC
SOIL DESCRIPTION
Surface Elevation: ± 292'
SAMPLES
DEPTH, feet
STANDARD PENETRATION RESISTANCE
(140 lb. weight, 30" drop)
▲ Blows per foot
0
25
50
5
10
15
SM
GM
1/15/74
52/6"
100/2"
0
25
50
● % Water content

SM — Very loose, moist to wet, brown, silty SAND.

GM — Very dense, moist, brown, gravelly, silty SAND.

Top of Rock 11.0 ft.

Soft to moderately hard, gray SANDSTONE.

Bottom of hole at 14.0 ft.

LEGEND

I 2.0" O.D. split spoon sample
II 3.0" O.D. thin-wall sample
* Sample not recovered
Atterberg limits:
Liquid limit
Natural water content
Plastic limit

Impervious seal
▽ Water level
▮ Piezometer tip
P Sampler pushed
USC Unified Soil Classification

Cathcart Sanitary Landfill Site

LOG OF BORING NO. B-5

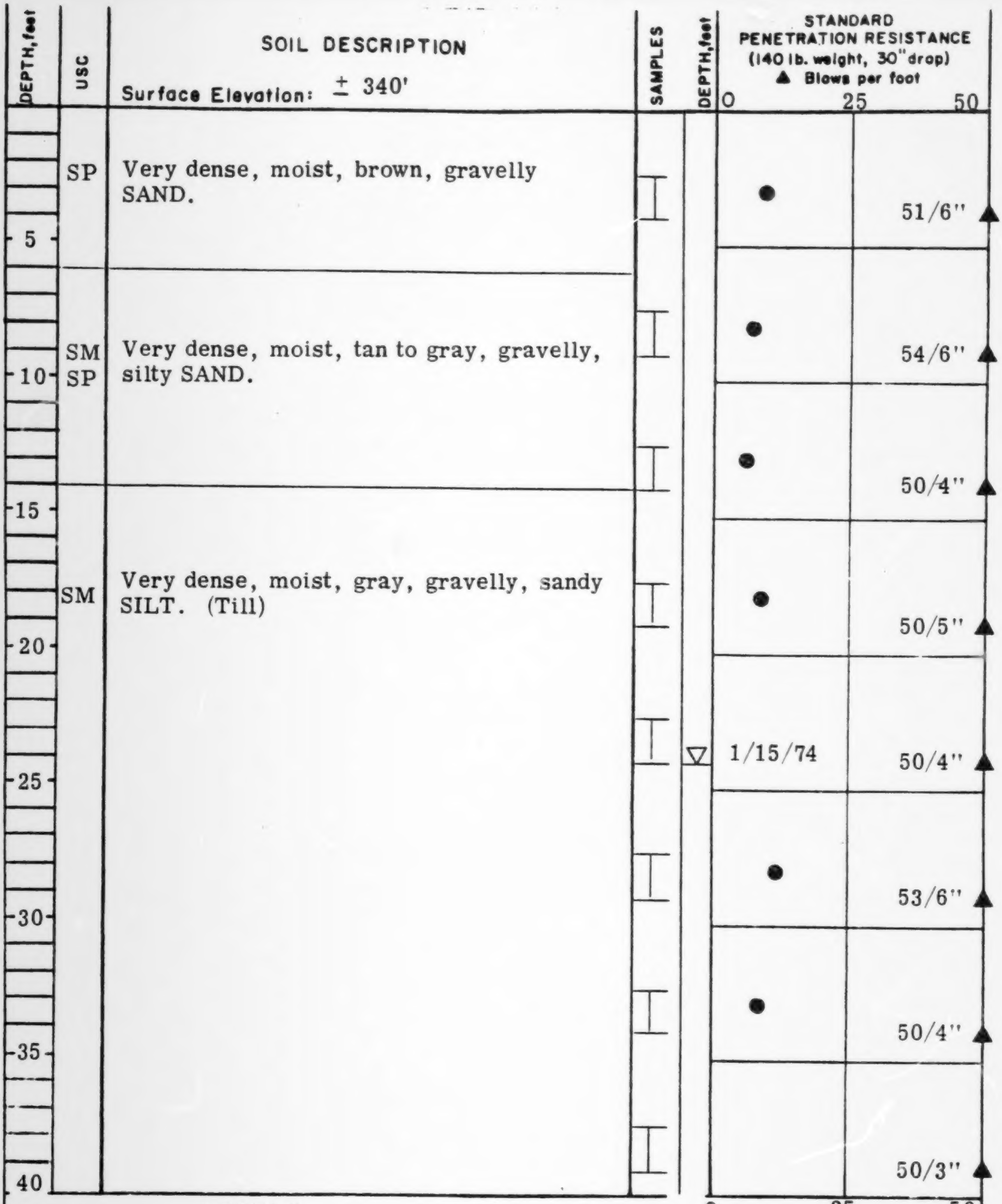
W-1035-64

GEOLABS, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS

Plate [illegible]

SOIL DESCRIPTION

Surface Elevation: ± 340'



SP Very dense, moist, brown, gravelly SAND.

SM SP Very dense, moist, tan to gray, gravelly, silty SAND.

SM Very dense, moist, gray, gravelly, sandy SILT. (Till)

LEGEND

- I 2.0" O.D. split spoon sample
- II 3.0" O.D. thin-wall sample
- * Sample not recovered
- Atterberg limits:
  - Liquid limit
  - Natural water content
  - Plastic limit
- Impervious seal
- ▽ Water level
- Piezometer tip
- P Sampler pushed
- USC Unified Soil Classification

Cathcart Sanitary Landfill Site

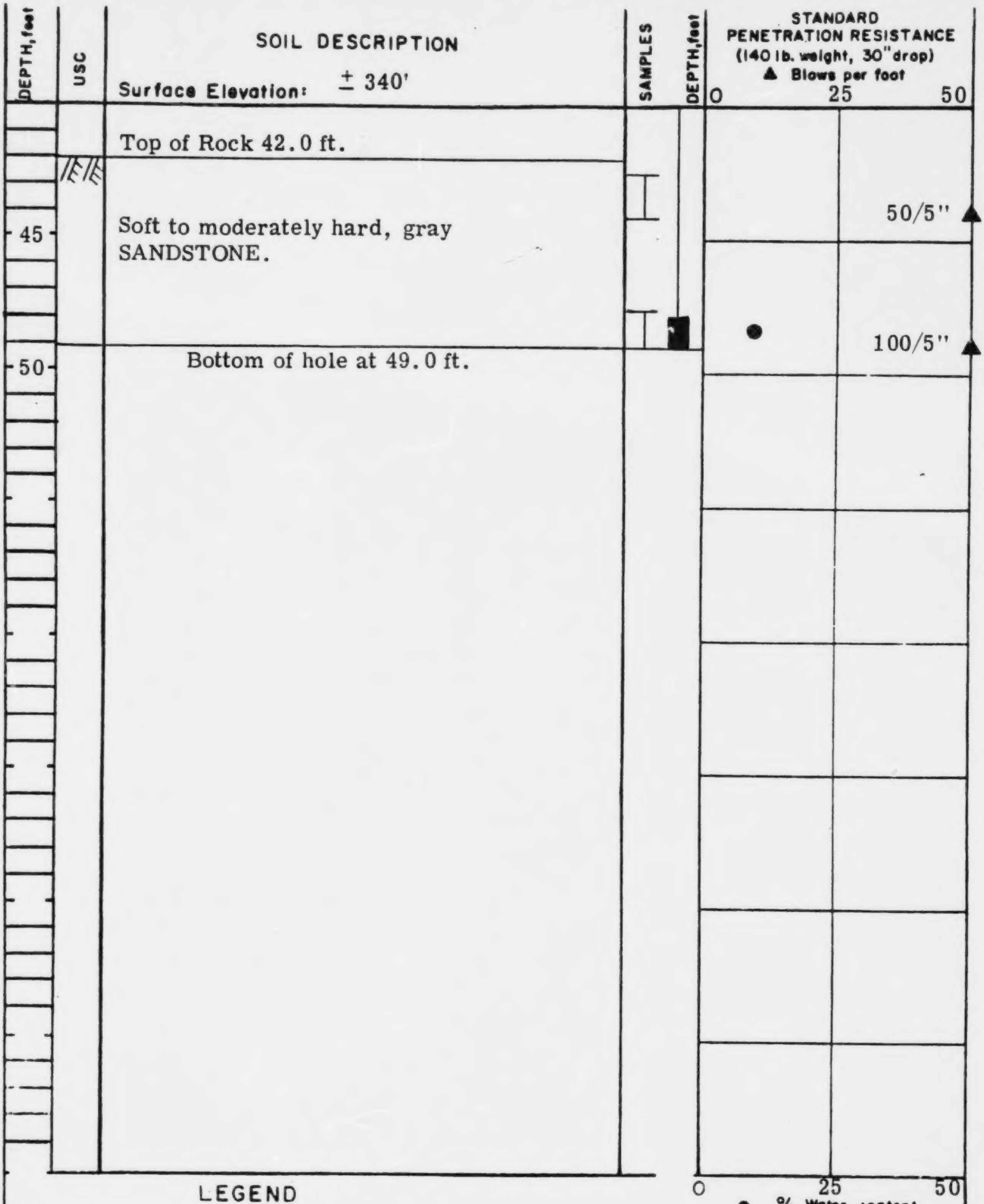
LOG OF BORING NO. B-6

W-1035-64

GEOLABS, INC.

SOIL MECHANICS & FOUNDATION ENGINEERS

Plate A-7



SOIL DESCRIPTION

Surface Elevation: ± 340'

Top of Rock 42.0 ft.

Soft to moderately hard, gray SANDSTONE.

Bottom of hole at 49.0 ft.

LEGEND

I 2.0" O.D. split spoon sample	Impervious seal
II 3.0" O.D. thin-wall sample	▽ Water level
* Sample not recovered	▮ Piezometer tip
Atterberg limits:	P Sampler pushed
←Liquid limit	USC Unified Soil Classification
Natural water content	
Plastic limit	

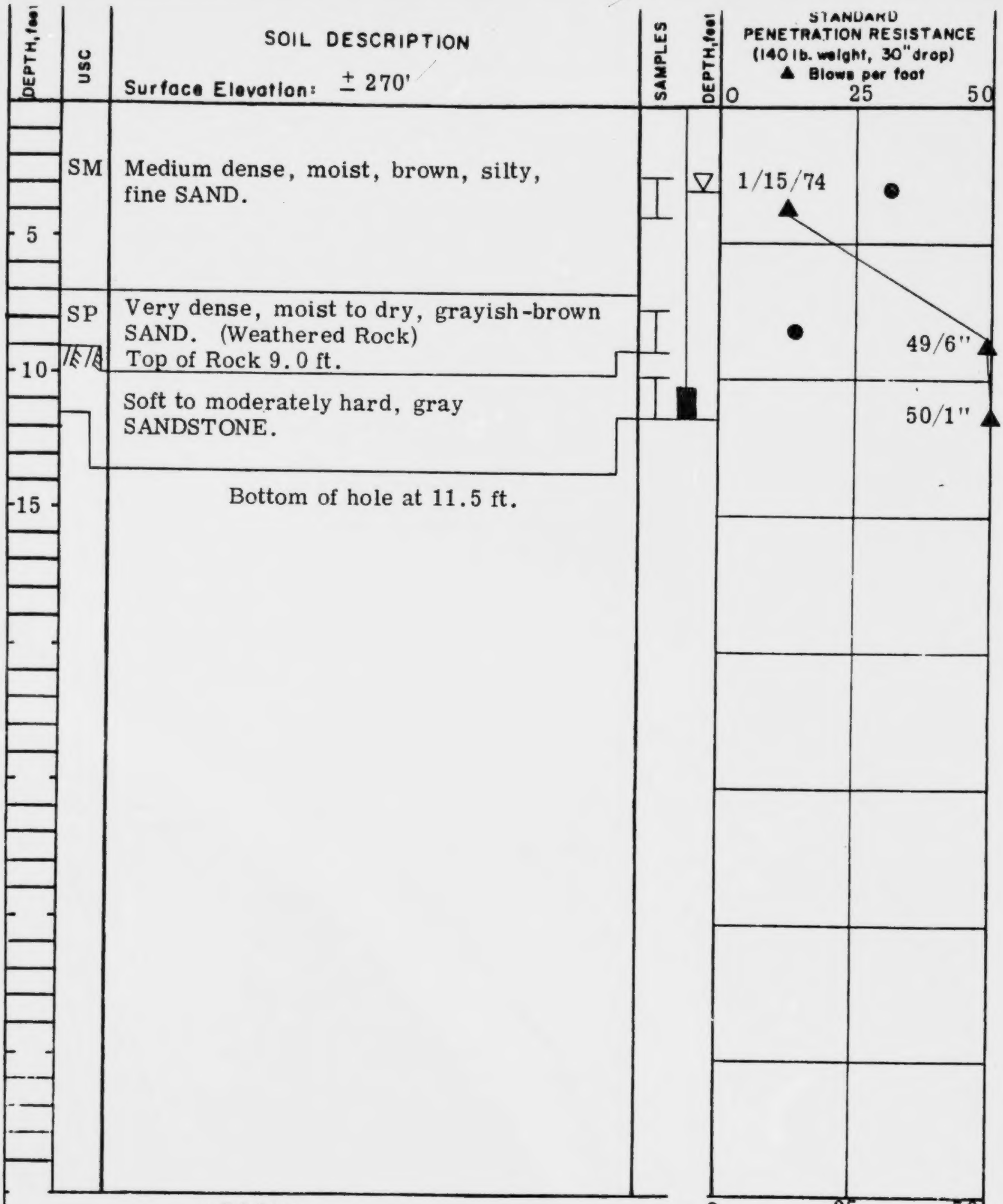
Cathcart Sanitary Landfill Site

LOG OF BORING NO. B-6 (cont.)

W-1035-64

GEOLABS, INC.

SOIL MECHANICS & FOUNDATION ENGINEERS



SOIL DESCRIPTION

Surface Elevation: ± 270'

USC	SOIL DESCRIPTION
SM	Medium dense, moist, brown, silty, fine SAND.
SP	Very dense, moist to dry, grayish-brown SAND. (Weathered Rock) Top of Rock 9.0 ft.
	Soft to moderately hard, gray SANDSTONE.

Bottom of hole at 11.5 ft.

STANDARD PENETRATION RESISTANCE (140 lb. weight, 30" drop)
▲ Blows per foot

● % Water content

LEGEND

Ⅰ 2.0" O.D. split spoon sample
Ⅱ 3.0" O.D. thin-wall sample
* Sample not recovered
Atterberg limits:
← Liquid limit
Natural water content
Plastic limit

Impervious seal
▽ Water level
■ Piezometer tip
P Sampler pushed
USC Unified Soil Classification

Cathcart Sanitary Landfill Site

LOG OF BORING NO. B-7

W-1035-64

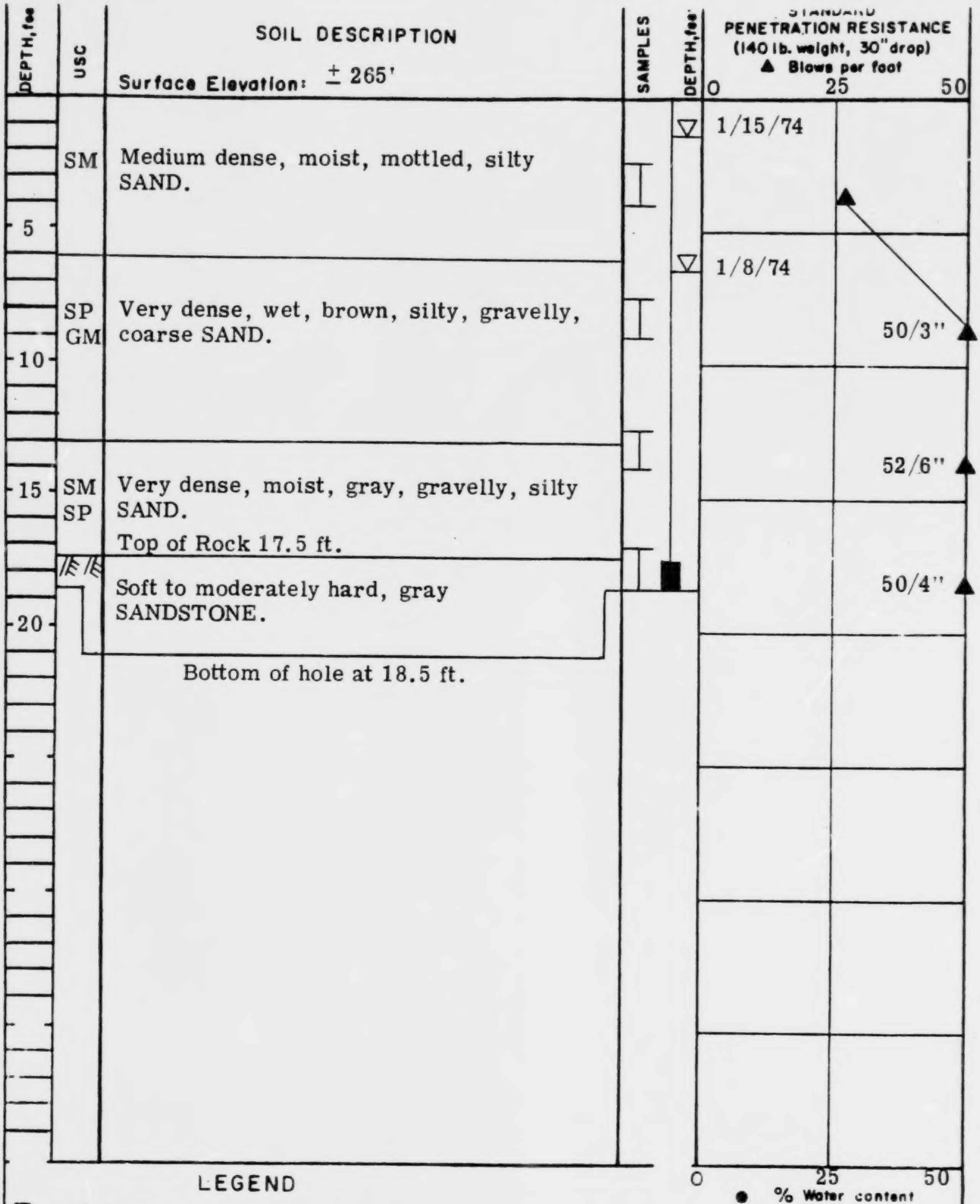
GEOLABS, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS

SOIL DESCRIPTION

Surface Elevation: ± 265'

USC	SOIL DESCRIPTION
SM	Medium dense, moist, mottled, silty SAND.
SP GM	Very dense, wet, brown, silty, gravelly, coarse SAND.
SM SP	Very dense, moist, gray, gravelly, silty SAND. Top of Rock 17.5 ft.
	Soft to moderately hard, gray SANDSTONE.

Bottom of hole at 18.5 ft.


DEPTH, feet
USC
SAMPLES
DEPTH, feet
STANDARD PENETRATION RESISTANCE
(140 lb. weight, 30" drop)
▲ Blows per foot
0
25
50
5
10
15
20
1/15/74
1/8/74
50/3"
52/6"
50/4"
0
25
50
● % Water content

LEGEND

I 2.0" O.D. split spoon sample
II 3.0" O.D. thin-wall sample
* Sample not recovered
Atterberg limits:
Liquid limit
Natural water content
Plastic limit

Impervious seal
▽ Water level
■ Piezometer tip
P Sampler pushed
USC Unified Soil Classification

Cathcart Sanitary Landfill Site

LOG OF BORING NO. B-8

W-1035-64

GEOLABS, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS

Plate A-9

TABLE A

TEST PIT LOGS

CATHCART SITE, SNOHOMISH COUNTY

Depth - ft.	Soil Classification
	Test Pit No. 1
0.0 - 3.0	Medium dense, moist, tan, silty SAND.
3.0 - 5.0	Medium dense, gray, moist, silty, fine SAND and sandy SILT.
5.0 - 6.5	Dense to very dense, gray, moist, gravelly, silty SAND. (Till) No water.
	Test Pit No. 2
0.0 - 0.5	Forest Duff and Topsoil.
0.5 - 4.0	Medium stiff, mottled brown and gray, fine, sandy SILT.
4.0 - 6.0	Hard, mottled brown and gray, gravelly SILT. (Weathered Till)
6.0 - 8.0	Medium dense, tan, moist SAND.
8.0 -	Hard, brown SANDSTONE. (Water seeps at 2.0 and 5.0 feet.)
	Test Pit No. 3
0.0 - 4.0	Medium dense, tan, moist to wet, silty, fine SAND.
4.0 - 9.5	Medium dense, mottled brown and gray, wet, silty, gravelly SAND.
9.5 -	SANDSTONE. (Strong water flow at 4.0 feet.)
	Test Pit No. 4
0.0 - 0.5	Forest Duff.
0.5 - 2.5	Loose, reddish-brown, weathered, silty, fine to medium SAND.
2.5 - 4.5	Medium dense, brown, slightly silty, fine to medium SAND with fragments of SANDSTONE.
4.5 - 5.5	Medium dense, brown, clean, medium SAND.
5.5 - 7.5	Dense, brown, silty SAND with fragments of SANDSTONE.
7.5 -	Refusal in hard SANDSTONE. (Water seeps at 7.5 feet.)

TEST PIT LOGS (CONT.)

Depth - ft.	Soil Classification
	Test Pit No. 5
0.0 - 0.5	Forest Duff.
0.5 - 3.0	Loose, brown, clayey, silty, medium to coarse SAND.
3.0 - 4.5	Loose, brown, clean, medium to coarse SAND.
4.5 - 8.0	Medium dense, brown to tan, clayey, silty SAND.
8.0 - 12.5	Very dense, brown and gray, silty, gravelly SAND. (Till) (Seeps at 8.0 feet.)
	Test Pit No. 6
0.0 - 2.5	Loose, black, organic Topsoil and Roots.
2.5 - 5.0	Medium dense to dense, tan to brown, clayey, silty, fine to medium SAND. (Weathered Sandstone)
5.0 -	Refusal in hard, brown Sandstone. (Slow seep at 5.0 feet.)
	Test Pit No. 7
0.0 - 1.0	Forest Duff and Topsoil.
1.0 - 2.5	Loose, reddish-brown, silty, fine SAND.
2.5 - 9.0	Dense to very dense, brown, silty, fine to medium SAND.
9.0 - 12.0	Very dense, blue-gray, silty, gravelly SAND. (Till) (Seeps at 3.0 and 9.0 feet.) (Slight caving at 8.0 feet.)
	Test Pit No. 8
0.0 - 0.5	Forest Duff and Topsoil.
0.5 - 2.5	Loose, brown, clayey, silty, medium to coarse SAND.
2.5 - 6.0	Medium dense, brown, silty, fine to coarse SAND with thin beds of clean SAND.
6.0 - 7.5	Very dense, brown, silty, pebbly SAND. (Till) (Seeps at 6.0 feet.)
	Test Pit No. 9
0.0 - 0.5	Forest Duff.
0.5 - 2.0	Loose, reddish-brown, very silty, gravelly SAND.
2.0 - 4.5	Loose, brown, silty, gravelly SAND with cobbles.
4.5 - 8.5	Very dense, gray, silty, gravelly SAND. (Till) (Seeps at 4.5 feet.)

TEST PIT LOGS (CONT.)

Depth - ft.	Soil Classification
	Test Pit No. 10
0.0 - 0.5	Forest Duff.
0.5 - 2.5	Loose, reddish-brown, very silty, fine to medium SAND.
2.5 - 8.0	Loose, brown, silty, fine to medium SAND with scattered pebbles and gravel.
8.0 - 10.0	Very dense, gray, silty, gravelly SAND. (Till) (No water.)
	Test Pit No. 11
0.0 - 0.5	Forest Duff and Topsoil.
0.5 - 2.0	Loose, brown, slightly silty, gravelly SAND.
2.0 - 7.0	Dense, brown, silty, gravelly SAND. (Till)
7.0 - 9.0	Very dense, brown, silty, gravelly SAND. (Seeps at 0.5 feet.)
	Test Pit No. 12
0.0 - 0.5	Forest Duff and Topsoil.
0.5 - 8.0	Medium dense, brown, silty SAND. (Weathered Sandstone)
8.0 - 9.0	Dense, brown, gravelly SANDSTONE. (Seeps at 7.5 and 8.0 feet.)
	Test Pit No. 13
0.0 - 0.5	Forest Duff.
0.5 - 3.0	Dense, brown, silty, fine to medium SAND with sandstone fragments. (Weathered Sandstone)
3.0 - 4.5	Very dense, brown SANDSTONE. (No water.)
	Test Pit No. 14
0.0 - 9.0	Medium dense, brown, silty, gravelly SAND.
9.0 - 10.0	Very dense, gray, silty, gravelly SAND. (Till) (Seeps at 9.0 feet.)
	Test Pit No. 15
0.0 - 0.5	Forest Duff.
0.5 - 6.0	Medium dense, brown, silty, gravelly SAND. (Weathered Till)
6.0 - 8.0	Very dense, gray, silty, gravelly SAND. (Till) (Seeps at 6.0 feet.)

TEST PIT LOGS (CONT.)

Depth - ft.	Soil Classification
	Test Pit No. 16
0.0 - 0.5	Forest Duff.
0.5 - 5.0	Medium dense, brown, silty, fine to medium SAND with scattered gravel.
5.0 - 7.0	Medium dense, brown, silty to clean, fine to medium SAND.
7.0 - 9.0	Very dense, gray, silty, gravelly SAND. (Till) (Seeps at 7.0 feet.)
	Test Pit No. 17
0.0 - 0.5	Forest Duff.
0.5 - 5.0	Medium dense, brown, silty, fine to medium SAND with scattered gravel.
5.0 - 7.0	Medium dense, brown, silty to clean, fine to medium SAND.
7.0 - 9.0	Very dense, gray, silty, gravelly SAND. (Till) (Top of till is at 7.5 feet.)
	Test Pit No. 18
0.0 - 0.5	Forest Duff.
0.5 - 2.5	Loose, brown, organic Topsoil.
2.5 - 5.5	Very stiff, brown, sandy CLAY.
5.5 - 7.5	Hard, blue, sandy SILT.
7.5 - 9.0	Dense, blue, silty, fine to medium SAND. (Strong seeps at 7.5 to 9.0 feet.)
	Test Pit No. 19
0.0 - 1.0	Loose, black, organic Topsoil.
1.0 - 5.0	Loose to medium dense, brown, sandy SILT.
5.0 - 8.0	Very stiff, brown SILT with thin beds of sandy SILT.
8.0 - 9.5	Dense, brown, silty SAND. (Strong seep at 8.5 feet.)
	Test Pit No. 20
0.0 - 0.5	Grass and Topsoil.
0.5 - 3.0	Loose to medium dense, reddish-brown, silty, fine to medium SAND.
3.0 - 5.5	Thin bedded, medium dense, brown, silty, fine to medium SAND.

TEST PIT LOGS (CONT.)

Depth - ft.	Soil Classification
	Test Pit No. 20 (continued)
5.5 - 6.0	Medium dense, brown, clean, fine to medium SAND.
6.0 - 9.0	Hard, brown, friable SANDSTONE.
9.0 - 9.5	Very hard, blue, dry SANDSTONE.
	(Seeps at 3.0 to 8.0 feet.)
	Test Pit No. 21
0.0 - 0.5	Forest Duff and Topsoil.
0.5 - 4.5	Medium stiff, yellow-brown, sandy SILT.
4.5 - 6.5	Loose to medium dense, gray, clean, medium to coarse, pebbly SAND. (Water bearing)
6.5 - 8.5	Dense, gray, sandy GRAVEL.
	(Water standing at 7.0 feet.
	Test Pit No. 22
0.0 - 0.5	Forest Duff and Topsoil.
0.5 - 3.5	Soft, brown, sandy, clayey SILT. (Weathered Rock)
3.5 - 8.5	Interbedded, hard, brown and gray, sandy SILT and silty SAND. (Some sandstone fragments) (Weathered Rock)
8.5 - 8.9	Hard, blue, silty, micaceous SANDSTONE.
	(Seeps at 8.5 feet.)
	Test Pit No. 23
0.0 - 0.5	Forest Duff and Topsoil.
0.5 - 4.0	Soft, brown, sandy, clayey SILT. (Weathered Rock)
4.0 - 8.5	Stiff, brown, sandy SILT with rock fragments. (Rock becomes harder with depth. (Weathered Rock)
8.5 - 8.6	Hard, brown SANDSTONE. (Dry. Impermeable.)
	Test Pit No. 24
0.0 - 0.5	Forest Duff and Topsoil.
0.5 - 1.0	Soft, reddish-brown, silty, sandy CLAY with roots.
1.0 - 4.0	Medium dense, gray and brown, silty, fine to coarse SAND with thin beds of stiff silt.
4.0 - 10.0	Dense, brown, very silty, fine to medium SAND with some gravel.
10.0 - 11.0	Dense, blue, silty, fine to medium SANDSTONE.
	(Seeps at 2.5 feet and 9.5 feet.)

TEST PIT LOGS (CONT.)

Depth - ft.	Soil Classification
	Test Pit No. 25
0.0 - 0.5	Forest Duff and Topsoil.
0.5 - 3.0	Soft, reddish brown, sandy SILT.
3.0 - 6.0	Stiff, brown, sandy SILT.
6.0 - 9.0	Medium dense, gray, clean SAND.
9.0 - 10.0	Hard, brown, silty CLAY.
10.0 - 11.0	Dense, blue SANDSTONE. (Seeps at 3.0 feet and 8.0 - 9.0 feet.)

APPENDIX B

LABORATORY TEST RESULTS

NATURAL MOISTURE CONTENT

Boring No.	Sample No.	Natural Moisture Content (%)
B-1A	S-1	21.8
	S-2	12.8
	S-3	11.0
B-1B	S-1	23.0
B-4	S-1	13.4
	S-2	11.0
	S-3	7.4
	S-4	9.2
	S-5	16.8
	S-6	20.6
	S-7	18.9
B-5	S-1	29.6
	S-2	16.1
B-6	S-1	12.9
	S-2	9.6
	S-3	8.5
	S-4	9.7
	S-6	10.8
	S-7	9.7
	S-10	11.5
B-7	S-1	28.8
	S-2	14.1

RESULTS OF PERMEABILITY TESTS

Test No.	Boring No.	Sample No.	Permeability (cm/sec)
1	B-3	S-1	6.42×10^{-7}
2	B-8	S-5	4.46×10^{-7}
3	B-6	S-8	2.56×10^{-5}
4	B-8	S-2	9.12×10^{-6}
5	B-6	S-5	1.04×10^{-5}

GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING

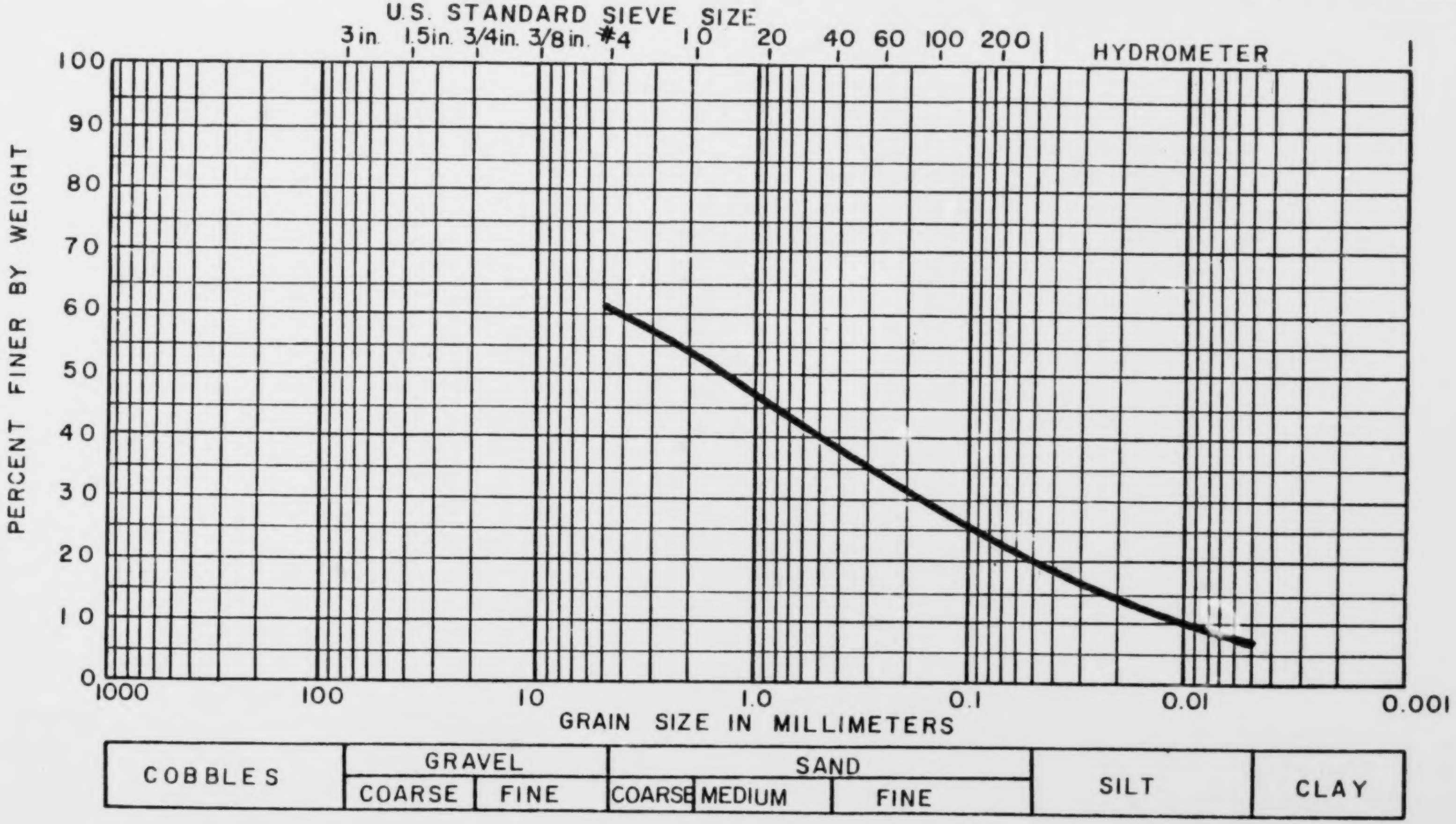
BORING NO. B-3, S-1

DEPTH 2.5' - 4.0'

W.O. 1035-64

PROJECT Cathcart Sanitary Landfill Site

PLATE B-3



GEOLABS, INC
GEOLOGY AND SOIL ENGINEERING

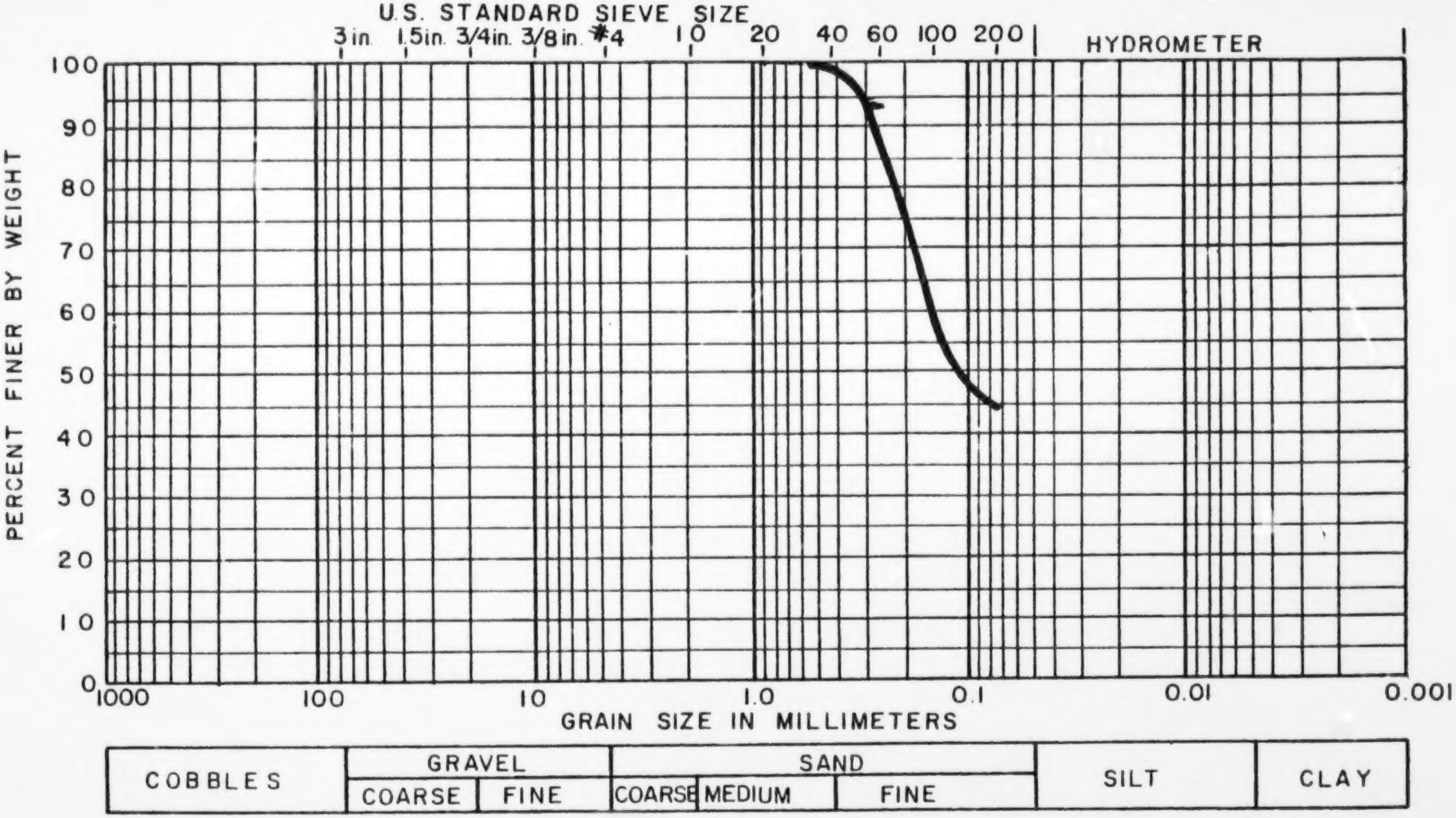
BORING NO. B-5, S-3

DEPTH 12.5' - 14.0'

W.O. 1035-64

PROJECT Cathcart Sanitary Landfill Site

PLATE B-4



GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING

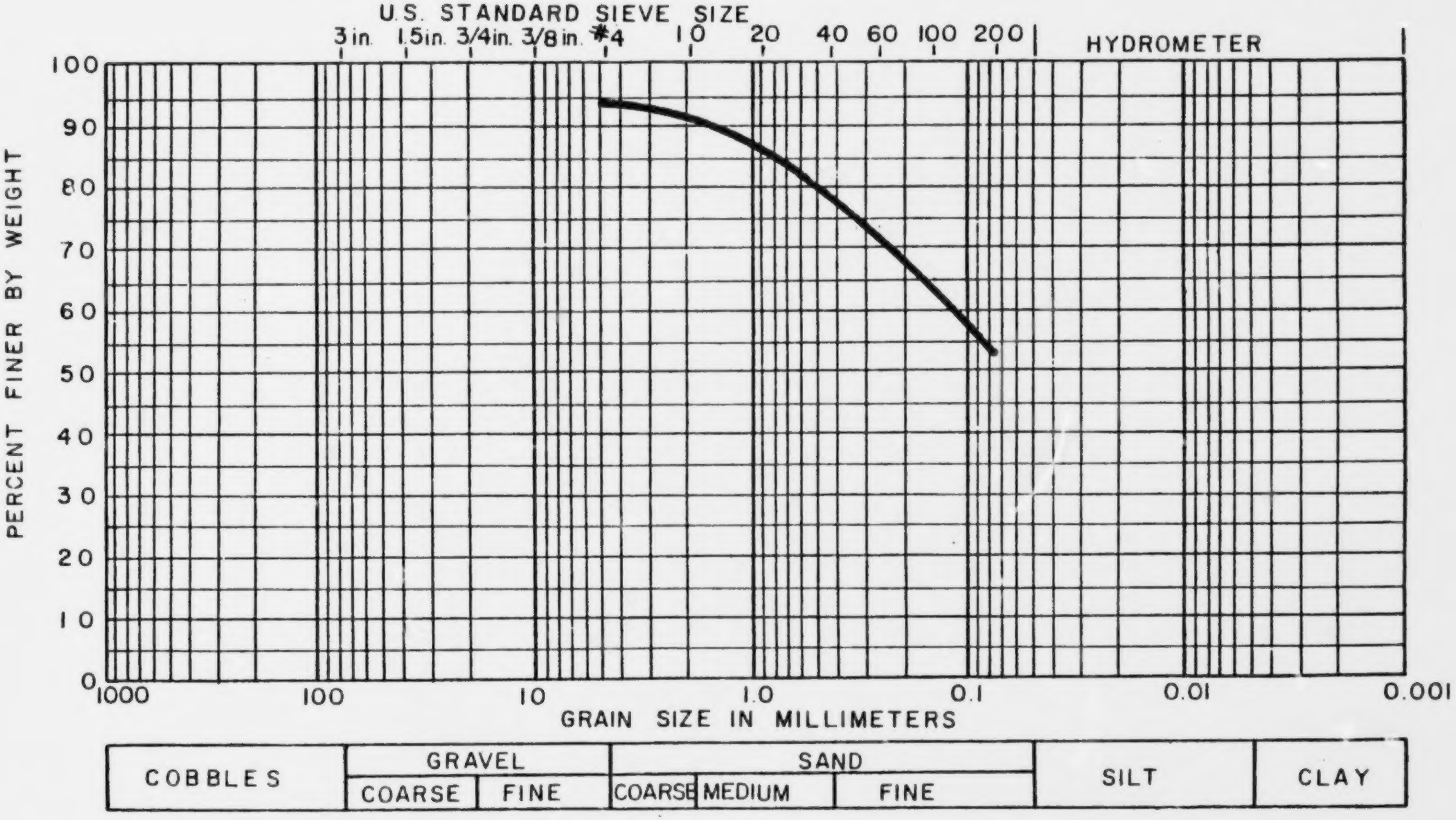
BORING NO. B-6, S-5

DEPTH 22.5' - 24.0'

W.O. 1035-64

PROJECT Cathcart Sanitary Landfill Site

PLATE B-5



GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING

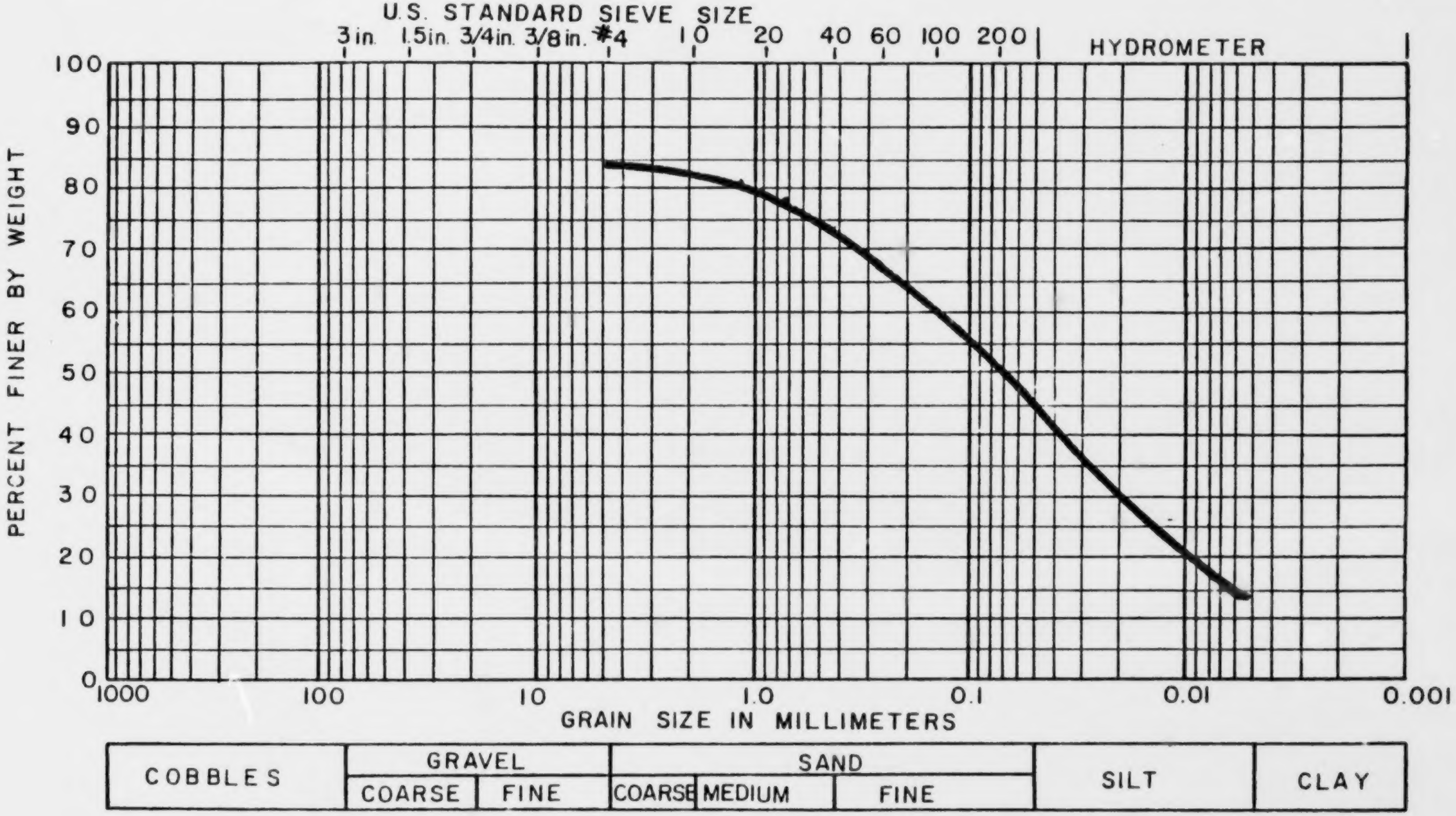
BORING NO. B-6, S-8

DEPTH 37.5' - 39.0'

W.O. 1035-64

PROJECT Cathcart Sanitary Landfill Site

PLATE B-6



GEOLABS, INC
GEOLOGY AND SOIL ENGINEERING

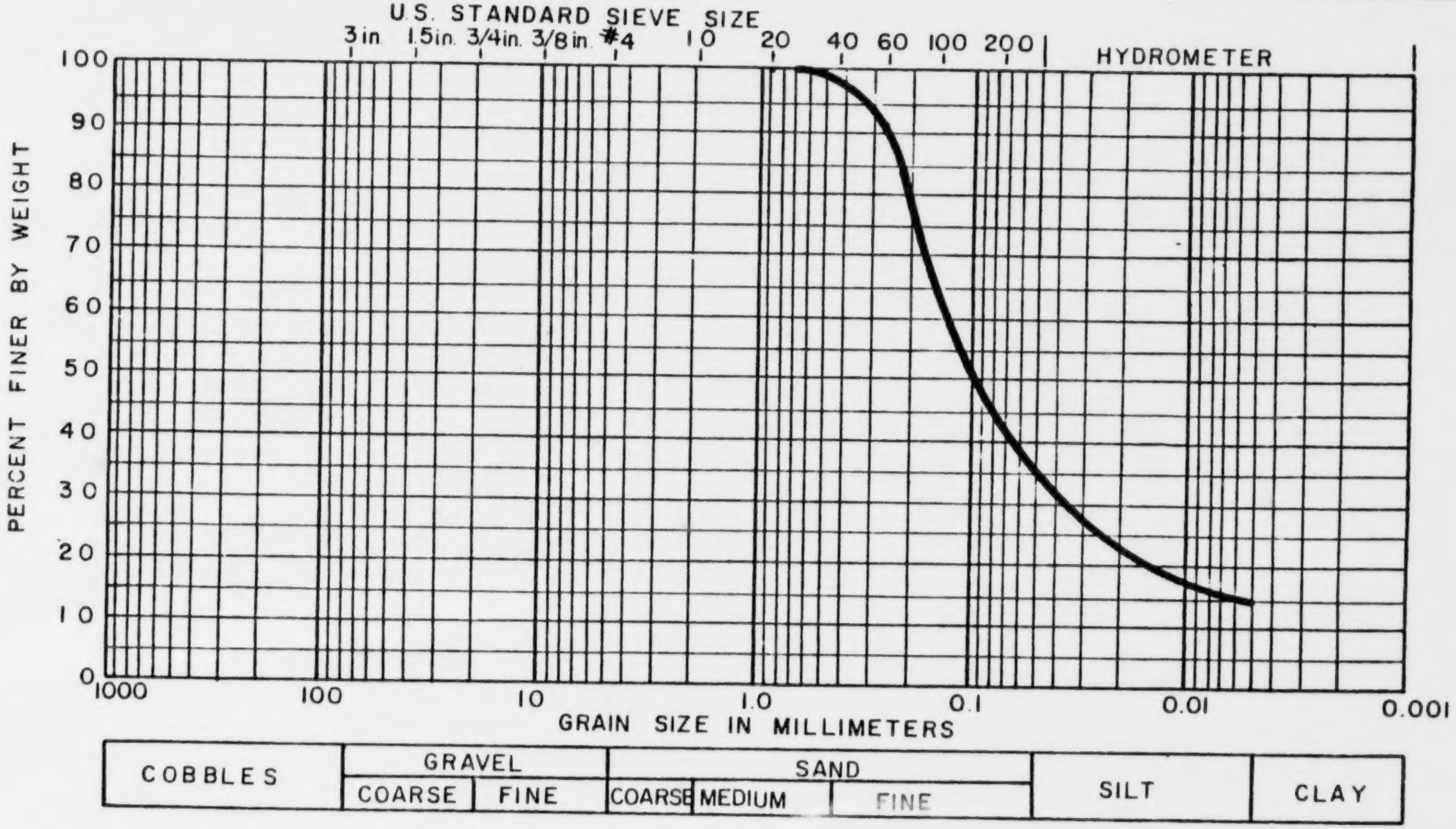
BORING NO B-7, S-3

DEPTH 10.0' - 11.5'

PROJECT Cathcart Sanitary Landfill Site

W.O. 1035-64

PLATE B-7



GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING

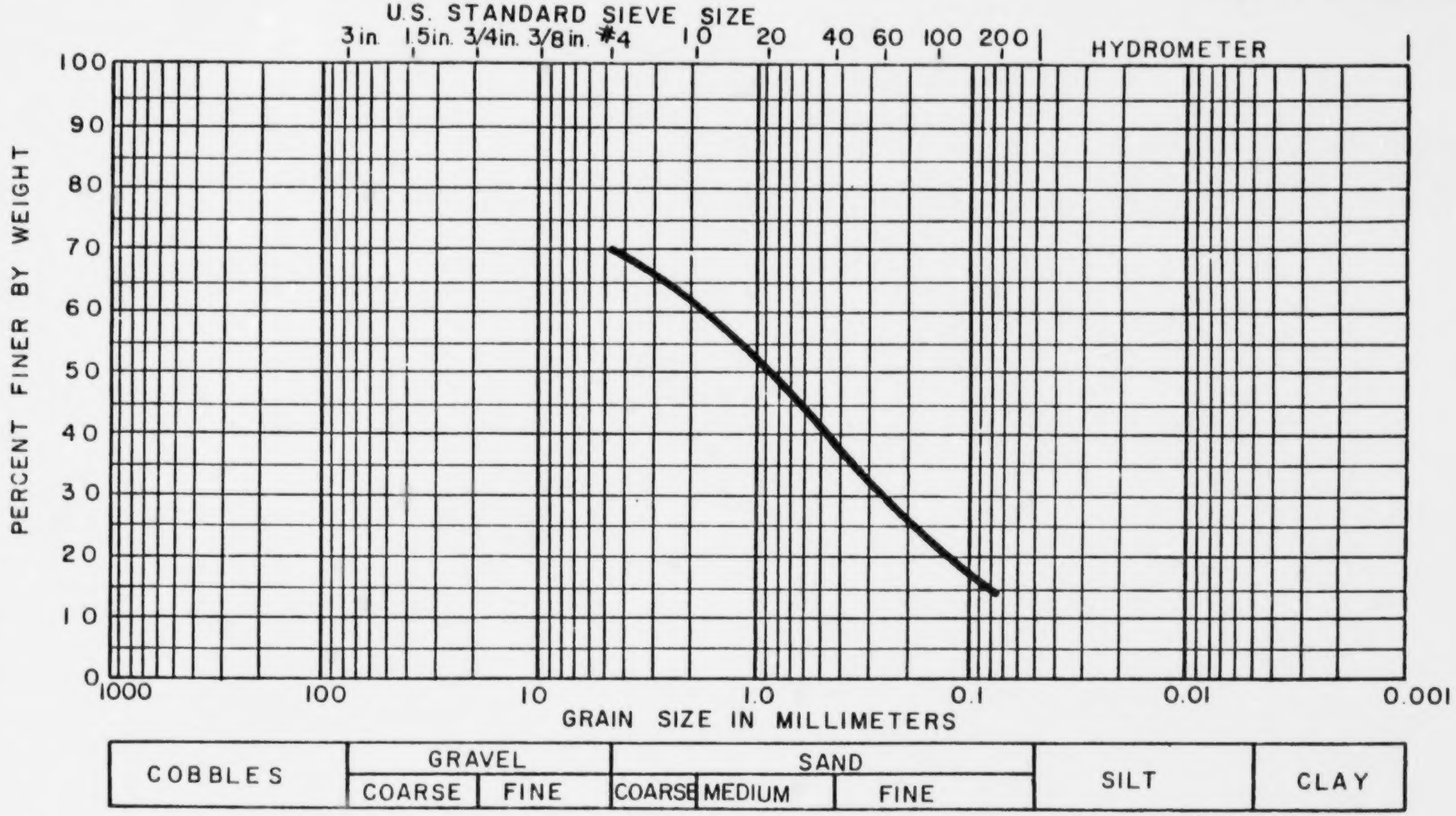
BORING NO B-8, S-2

DEPTH 7.5' - 9.0'

W.O. 1035-64

PROJECT Cathcart Sanitary Landfill Site

PLATE B-8



APPENDIX F

SUBSURFACE INVESTIGATION AND PERCOLATION TESTING OF BEDROCK LANDFILL SITE

CATHCART, WASHINGTON

W-1035 -66

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GEOLABS-WASHINGTON, Inc.

Foundation and Soils Engineering, Geology

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502 So. 11th St. • Tacoma, Washington 98402 • (206) 272-8363
Telex 32-9424 3416 Everett Avenue • Everett, Washington 98201 • (206) 259-0817

August 9, 1974 W-1035-66

Stevens, Thompson & Runyan, Inc.
700 Plaza 600
Seattle, Washington 98101

Attention: Mr. Dirk Van Woerden

Subject: Subsurface Investigation and Percolation Testing of Bedrock
Landfill Site
Cathcart, Washington

Gentlemen:

This report presents the results of our subsurface investigation and permeability testing of the bedrock formation at the Cathcart landfill site. The test location was selected considering estimated depth of bedrock and close proximity to an existing surface drainage path. It is our opinion that the selection of the test site is fairly representative of bedrock conditions throughout the site. The purpose of this study was to investigate the integrity and permeability of the bedrock formation which consists of massive to interbedded Sandstone and Siltstone.

SUBSURFACE INVESTIGATION

The subsurface investigation consisted of drilling one boring to a depth of 26 feet below the existing ground surface, which was approximately Elevation 330 at the test location.

The overburden soils, consisting of sandy silts and gravelly sands, were encountered to about 8 feet in depth. Casing was then installed in the boring to a depth of 9 feet to seal off the sandstone from the overlying soils. To insure the casing was seated in bedrock, a constant head test was run. Water leakage was not observed and the casing was considered sealed. The boring was then advanced using an NX diamond coring bit which allowed recovery of rock samples. After a core run of 5 to 6 feet, permeability tests were conducted to determine water loss in the bedrock formation. The hole was sealed off and water pumped in under pressure. Water pressure was

BRANCH OFFICES IN MOST PRINCIPAL CITIES

increased in increments of 5 psi, and maintained for a certain time interval. Any water loss was noted and recorded for each pressure increment. (An increase of 1 psi is equivalent to a rise in head of 2.31 feet.) This process continued until 15 psi had been attained, then pressure was reduced in 5 psi increments down to the initial starting pressure, recording water loss for each increment. Two other core runs were made to a depth of 18 feet into bedrock and tested in the same manner as the first section. After completion of drilling and water testing the last section, the entire length of sealed hole in bedrock was pressure tested in increments. The maximum pressure used for this test was 20 psi.

The location of the test boring is presented on the Site Plan, Plate I, and water test data and boring log in the Appendix.

SUBSURFACE CONDITIONS

Our boring indicated very soft, wet, dark brown, sandy silt to 3.5 feet, underlain to a depth of 8 feet with medium dense, moist, yellow-brown, gravelly, medium sand. These overlying sandy silts and sands represent post glacial deposits resting on older Oligocene sandstone. These deposits have been discussed in more detail in our earlier report (Geolabs Report, W-1035-64, dated February 1974).

The bedrock formation was encountered at a depth of 8 feet below the existing ground surface. Bedrock consists of thin to medium interbedded siltstone and sandstone. The sandstone varies from medium to coarse grained. The bedrock is moderately hard to hard, unweathered, and moderately fractured. The bedrock surface shows a moderate degree of weathering and fracturing that lessens with depth. The Rock Quality Designation (RQD) was used as an indication of discontinuities and a more massive and solid structure.

DISCUSSION AND RECOMMENDATIONS

General

The boring and permeability test performed for this additional investigation has confirmed our contention in our original report that the bedrock is relatively impermeable. The existence of fractures near the rock surface could easily be located after the overburden soils are excavated and sealed. The integrity of the bedrock, without considering the joints and fractures, is sound and impermeable, thus sealing of these minor openings will give an impermeable barrier for leachate control. It is our opinion that the joints and fractures in the rock are responsible for the minor water losses sustained in our tests.

Interpretation of Test Results

Test No. 1, run from 9.1 to 15.3 feet, showed a minor loss at 15 psi and no loss of water at lower pressures. The permeability at 15 psi is about 13 cubic feet per square foot per year. This minor loss may be due to hairline fractures in the upper weathered bedrock.

The second test from 15 to 21.3 feet showed no loss of water which is indicative of a sound impermeable bedrock.

The third test from 21 to 26 feet indicated a loss at 10 and 15 psi up to 1.3 gallons per minute (gpm) at 15 psi, with 0.4 and 0.1 gpm at 10 psi. The permeability at 15 psi was 166 cubic feet/square foot/year. No loss was observed at 5 psi. This may be due to a joint or contact plane between bedded siltstone and sandstone found at about 24 feet.

The fourth test, which was performed on the entire section of bedrock, showed lesser water loss than the third test, which may be an indication of sealing the fracture. The permeability rate for this test varied from 64 to 36 cubic feet per square foot per year. The drop reduction may be due to a partial sealing of the joint network.

Sealing of Joints

In our opinion, the losses sustained in our tests can be considered minor and could be reduced or eliminated by sealing joints or fractures encountered at the bedrock surface after the overburden has been removed.

The exposed bedrock surface should be inspected by an experienced engineering geologist or Soils Engineer to locate areas that will require sealing. The method of sealing should be left to the contractor's discretion, and in such a manner as to assure proper sealing of the opening. It is our opinion that a pressure grouting method should be used to obtain sufficient penetration of the grout into the joint. Sealing of the surface joints and fractures should be sufficient to obtain a relatively impervious bedrock foundation.

We appreciate the opportunity to be of service to you on this project. If you have any questions or require clarification of any point in this report, please feel free to contact us.

The following Plate and Appendix are included and complete this report:

Plate 1	Site Plan
Appendix	Test Data

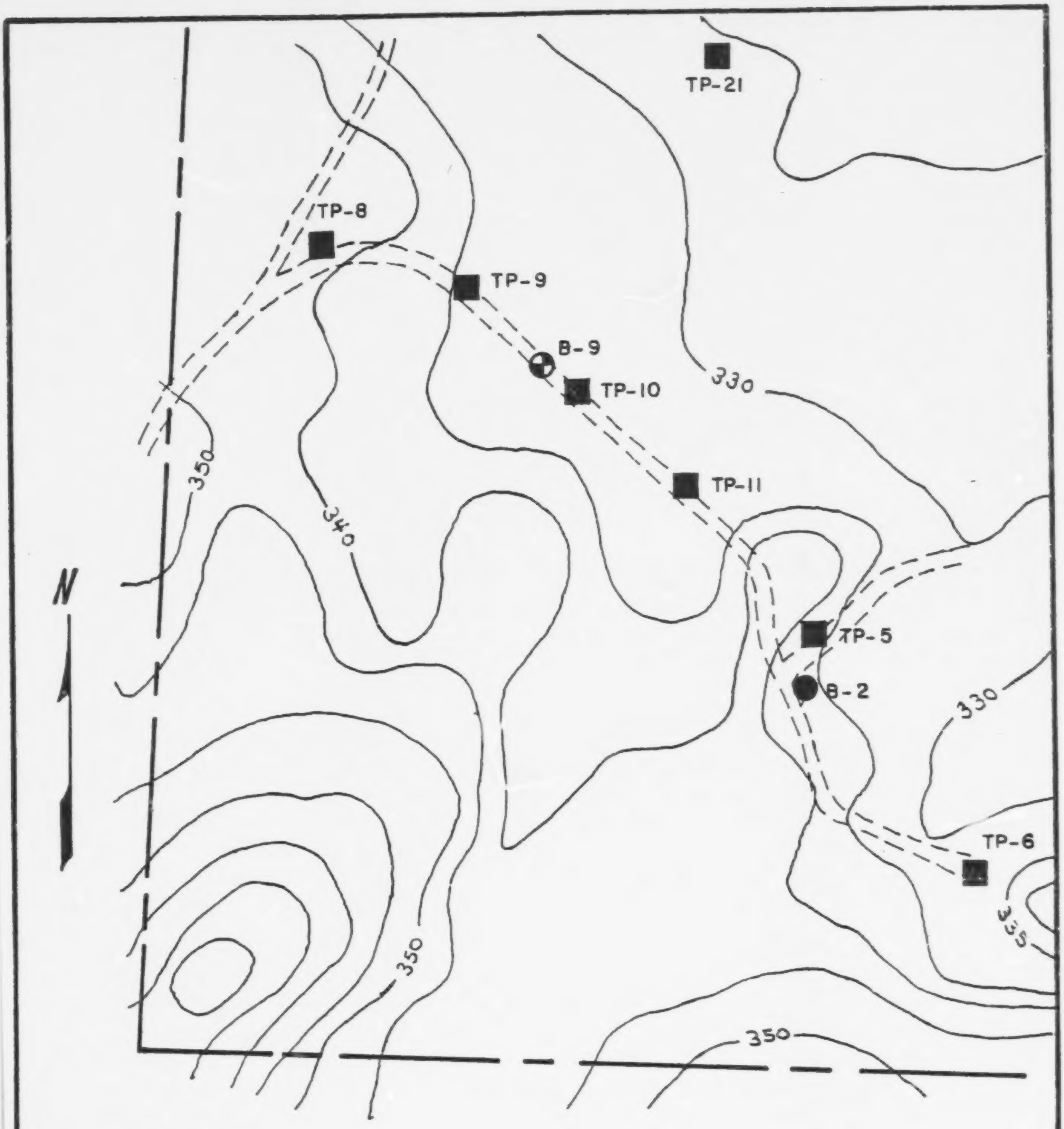
Respectfully submitted,

GEOLABS-WASHINGTON, INC.

Robert S. Levinson, P.E.
Chief Engineer

RSL/mh

ROBERT S. LEVINSON
STATE OF WASHINGTON
14691
REGISTERED
PROFESSIONAL ENGINEER


TP-21
TP-8
TP-9
B-9
TP-10
330
TP-11
350
340
N
TP-5
B-2
330
TP-6
335
350
350

LEGEND

ROAD
PROPERTY LINE
CONTOUR LINE-5' INTERVAL
● PREVIOUS BORING
■ PREVIOUS TEST PIT
◒ PRESENT BORING

BORING LOCATION MAP

GEOLABS, INC.
GEOLOGY AND SOIL ENGINEERING

DATE July 1974 BY AH
SCALE 1"= 100' W.O. 1035-66

PLATE 1

DEPTH, ft.	DIAGRAM	DESCRIPTION SURFACE ELEVATION: 330 ft.	TESTS	PERCENT RECOVERY
		Very soft, dark brown, wet, sandy SILT.		
5		Medium dense, yellow-brown, moist, gravelly, medium SAND.	▽	7/19/74
10		Gray to gray-green, medium hard to hard, fine to medium grained SANDSTONE and SILTSTONE in lenses to 6 inches thick.	1 4	Core Run 1 % recovered = 63.6 RQD = 0
				Core Run 2 % recovered = 92.1 RQD = 28.6%
15			2	Core Run 3 % recovered = 100 RQD = 0
		Coarse grained SANDSTONE lens. Soft, medium grained SANDSTONE lens.		
20				Core Run 4 % recovered = 100 RQD = 40%
			3	Core Run 5 % recovered = 97.8 RQD = 97.8%
25		Joint		
		Boring terminated at 26' on 7/22/74		
30				

LEGEND

I 1	Water Pressure Test Location and Number
▽	Water Level
RQD	Rock Quality Designator

Snohomish County Sanitary Landfill
Cathcart Site

LOG OF BORING NO. B-9
W-1035-66
GEOLABS, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS

Plate

WATER PRESSURE TEST RESULTS

Test No. 1 (Depth 9.1' - 15.3')

Pressure (psi)	Time of Test (minutes)	Water Loss (gpm)	Permeability Rate (foot^3/foot^2/year)
5	3	0	0
10	3	0	0
15	7	.086	12.99
10	3	0	0
5	3	0	0

Test No. 2 (Depth 15' - 21.3')

Pressure (psi)	Time of Test (minutes)	Water Loss (gpm)	Permeability Rate (foot^3/foot^2/year)
5	3	0	0
10	3	0	0
15	3	0	0
10	3	0	0
5	3	0	0

Test No. 3 (Depth 21' - 26')

Pressure (psi)	Time of Test (minutes)	Water Loss (gpm)	Permeability Rate $(\text{foot}^3/\text{foot}^2/\text{year})$
5	3	0	0
10	3	.37	56.08
15	3	1.33	166.12
10	3	.1	
5	3	0	

Test No. 4 (Depth 10' - 26')

Pressure (psi)	Time of Test (minutes)	Water Loss (gpm)	Permeability Rate $(\text{foot}^3/\text{foot}^2/\text{year})$
5	3	.03	2.66
10	3	.93	62.77
15	3	.67	36.54
20	3	.93	42.54
15	3	0	
10	3	0	
5	3	0	